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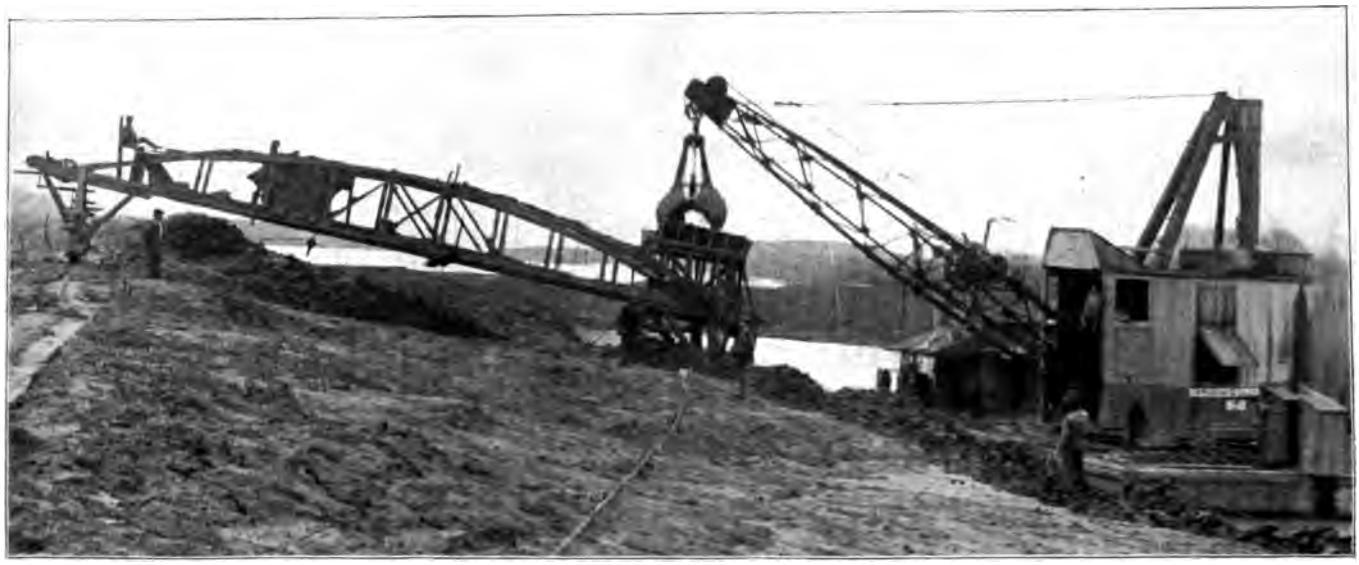
A BEAR HUNT IN THE GREAT YAZOO MISSISSIPPI DELTA—BUT FOR THE DISASTER OF OVERFLOWS IN THE PAST, FERTILE PLANTATIONS WOULD BE HERE



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RIPARIAN LANDS OF THE MISSISSIPPI RIVER

PAST—PRESENT—PROSPECTIVE

BEING

A collection of Essays and Discussions of Problems Affecting the Improvement of Navigation of the Mississippi River, Bank Protection, Harbor Improvement, its Levee System and the Permanent Deepening of the Channel at its Mouth, together with some Legal Aspects and Economic Features, by various Contributors

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ALSO

A Brief Review of the Attractions of, and the Possibilities of Development in, the Largest Alluvial Basin in the World

BY

FRANK H. TOMPKINS

Special Representative Interstate Mississippi River Improvement and Levee Association

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BY FRANK H. TOMPKINS
NEW ORLEANS, LA.

A BIT OF HISTORY.

In June, 1890, there assembled at Vicksburg, Miss., a convention which more nearly represented the entire alluvial section of the Mississippi River probably than any other that ever met. It was in the midst of one of the largest overflows, and at a time when the people had come to the conclusion that their efforts and their sacrifices in the way of taxation were futile to cope with the deluges which periodically swept down upon them from the northern and western rivers, that the grave problem, which they had spent millions in a vain endeavor to solve, was beyond their single-handed ability. It was generally known that this convention would outline a policy by which the United States government and the people of the entire United States should be brought to a realization of the great commercial value of the millions of acres which lie in the great basins that were annually overswept, and that a more general understanding of the subject would lead Congress to solve this problem—to bring security to the homes of the people and to contribute to the development of the vast areas which were yet untrodden, almost, by the foot of man.

This convention adopted a report made by the engineers—both army and civil, uniting in a general statement. To aid to carry out these recommendations and to secure from Congress an allotment necessary to meet the requirements of the situation, the convention organized itself into an association called the Interstate Mississippi River Improvement and Levee Association, with Hon. Charles Scott, of Rosedale, Miss., as President, and Mr. W. A. Everman, then of Memphis, Tenn., but now of Greenville, Miss., as Secretary, with the necessary executive and other committees. A Bureau of Correspondence was opened at Washington City and many hundreds of thousands of documents were sent all over the United States. The leading journals of the United States, both in the East and in the West, strongly urged the necessity of protecting the rich alluvial valley.

The Manufacturers' Record, a journal of Southern development, sent a special commissioner through the whole fertile area threatened by overflows and the subject was treated in all its phases in its columns. These series of articles were afterward printed in book form and extensively circulated.

It is no derogation to Congress to say that it is moved by public sentiment. In fact it is the theory upon which this country is builded, that such should be the case, and the only way to impress such a body as the Congress coming from so large a constituency having so diverse and oftentimes conflicting interests is to educate them up to the importance and nationality of a subject.

On this principle this association has worked under the wise direction of President Scott, and nothing has been left undone that could be accomplished with the limited means at hand. Of course much more could have been done in the way of disseminating information and molding public sentiment in this matter, had larger funds been obtainable, but anyhow a sufficiency has been obtained, probably, for a conservative use.

Since that time all river and commercial conventions held in the Valley, and some held in remote parts of the United States, have had delegates present to represent the interests of the people who live behind the levees. At no time in the passage of a bill before Congress for the Great River has this Association been without a special representative, and often delegations were present with facts and figures to demonstrate the right of the people of the Mississippi Valley to appropriations and national assistance for the improving of the Mississippi River and the building and strengthening of its levee system. Capt. Patrick Henry, of Arkansas, is the representative of the Association.

This continual agitation has greatly strengthened public sentiment in favor of larger appropriations by the general government. The plans as out-

[illegible]

lined and carried into effect have had the endorsement of every member of Congress directly interested in the Mississippi River sections. And they have realized that the work of the people who live behind the levees, directed through the commercial and financial circles which are interested in the safety and development of these valleys, is a potent factor in upholding their hands at Washington. The Mississippi River has not lacked for able champions in Congress from the early agitation for the formation of the Mississippi River Commission down to the present time.

The first distinct triumph of the levee interests in Congress was in 1891, when an emergency bill of one million dollars was passed by Congress to repair the ravages of the overflow of 1890. This appropriation was unrestricted by the clause which had existed in former laws confining the appropriations by the general government to building of levees only where "in the judgment of the Mississippi River Commission it was necessary for the improvement of channel navigation." This appropriation was available to repair levees wherever the floods had swept them away.

Following this came the ten million dollar continous contract law from which over "six" million dollars was applied to extending and enlarging the levees. The final allotment from this act was expended during the year of 1899. The failure of the House Committee on Rivers and Harbors to report a general River and Harbor Bill at the last session of Congress caused much apprehension on the part of the people of the Valley that there would be a temporary cessation of the levee and river improvement work by the government, but the sentiment in favor of the Mississippi River improvements—regarding it as the great national highway of the United States, was so strong that all precedents were diregarded and the usual appropriation was placed on the Sundry Civil Bill in the Senate and adopted by the House of Conferees.

This was simply carrying out the spirit of the Continuous Appropriation Act which had expired.

But to return to the statement regarding the general work of the Association. It will be recalled by the people of the Valley that in 1897, when the expenditures authorized by the above mentioned contract bill was about to conclude, the Senate passed a resolution ordering an investigation of the whole subject and appointed a sub-committee of the Committee on Commerce to make it.

In June following the action and preceding the visit of this sub-committee, the representative of the various levee boards of the Mississippi River met in New York at a session of the Mississippi River Commission.

At a meeting of these representatives, called to consider the visit of this sub-committee, it was requested that Capt. Patrick Henry, representative of this Association, should secure full data relating to the alluvial lands of the Mississippi River to aid them in their investigations. While this work was in progress President Scott directed a renewal of the correspondence and propaganda of information which reached the commercial interests of all parts of the United States, supplying information, maps, charts, etc., to be used by the industrial and commercial firms, corporations and organizations to further the protection of the alluvial lands of the Mississippi River. This plan was very successful and enabled our people to feel the assurance that the improvement of the Mississippi River and the protection of these rich alluvial basins through appropriations from the general government would not only be endorsed by the people of the United States, but that Congress would be urged to action by them. And their promises were immediately followed by persistent demands for the solution of this problem.

This has been disparaged by some as a lobby or lobbying plan, but what if it is? There is no wrong in a lobby if properly used and for a proper purpose. The Constitution of the United States gives the people the right of petition, and it is certainly their right to ask those who are equally interested with them in a matter of importance to their commercial or industrial well-being to join with them in petition. From time immemorial it has been the custom to send delegates to Washington City and to otherwise influence a proper action of Congress to protect and develop national interests. Our friends of the Eastern and Central States have understood this better, and have applied it with more frequency in the up-building of great manufacturing interests, than we have. And it is the only successful, and, in fact, the only logical method by which interests can be properly presented to Congress. The House represents three hundred and fifty-six different constituencies and the Senate represents the whole people of all the different States.

Thus Congress is a body of units, and these units must look out for the individual district first. Now it stands to reason that any measure which benefits the constituents of a majority of these units should be successful in Congress. If the increased trade which should spring from the development made possible by the protection of these great basins from the dangers of recurring floods, interest the constituents of a majority of these units, then it should be a matter of easy accomplishment to secure this protection.

Thus the commercial and manufacturing interests of the United States, ever alert to the importance of the development of new avenues of trade, as well as to the safety of that which they are at present enjoying, have been warmly seconding the people of the Mississippi Valley in their efforts to secure immunity from water and to permit the further development of the trade which emanates from these fertile basins. And it is largely due to their efforts that increased appropriations have been made by Congress, and it will be through their continued efforts and good offices that this protection will be finally accomplished. The people of this section have shown, and are still showing, a commendable activity and abundant self-sacrifice in grappling with the great problem which has confronted them, and certainly they deserve well for the heroic and expensive fight which they have made to stay the ravages of the great stream which passes their door and annually threatens their homes and their property.

The line of levees behind which they live, while not up to the requirements of absolute safety, are of such height and are now built with such mechanical skill, and by such improved methods, that they feel a security against almost any ordinary high water, but the agitation of the question in Congress, and by the people themselves, through their associations, and by the aid of their commercial correspondence throughout the United States, must and will persistently continue until levees are raised and fortified, to become, like the dikes of Holland, so strong that life and property shall be as secure from threatened invasion of waters as on the fertile plains of Illinois, Iowa or Kansas.

THE HOME OF THE PRESIDENT OF THE UNITED STATES

THANKS!

IT IS pleasant to feel grateful, and pleasanter still to be able to give expression to it. So I dedicate this page as an offering of thanks in acknowledgment of aid, without which this book never could have been issued.

To the contributors of the able articles presented.

To the Levee Boards of the Mississippi River Districts.

To Police Juries, City Councils and Commercial Organizations.

To Hon. Charles Scott, Mr. W. A. Everman, Mr. P. M. Harding, President Delta Trust and Banking Company; Messrs. Duffin Bros. & McGehee and Caldwell & Smith, for valuable financial aid.

To members of Congress and others who warmly endorsed the work in advance.

To Hons. J. M. Jayne, J. E. Ransdell, John B. Driver and Mr. Harry N. Pharr, for active assistance in many ways.

To the Railroads—the great developers of our alluvial sections—for transportation and other assistance.

To many generous firms, corporations and individuals, for offerings to bear the large expense of this work.

To the Press—last but not least—for cordial and unreserved commendation.

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THE LATE W. A. PERCY

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Editor of the Baltimore Manufacturers' Record
(See page 4

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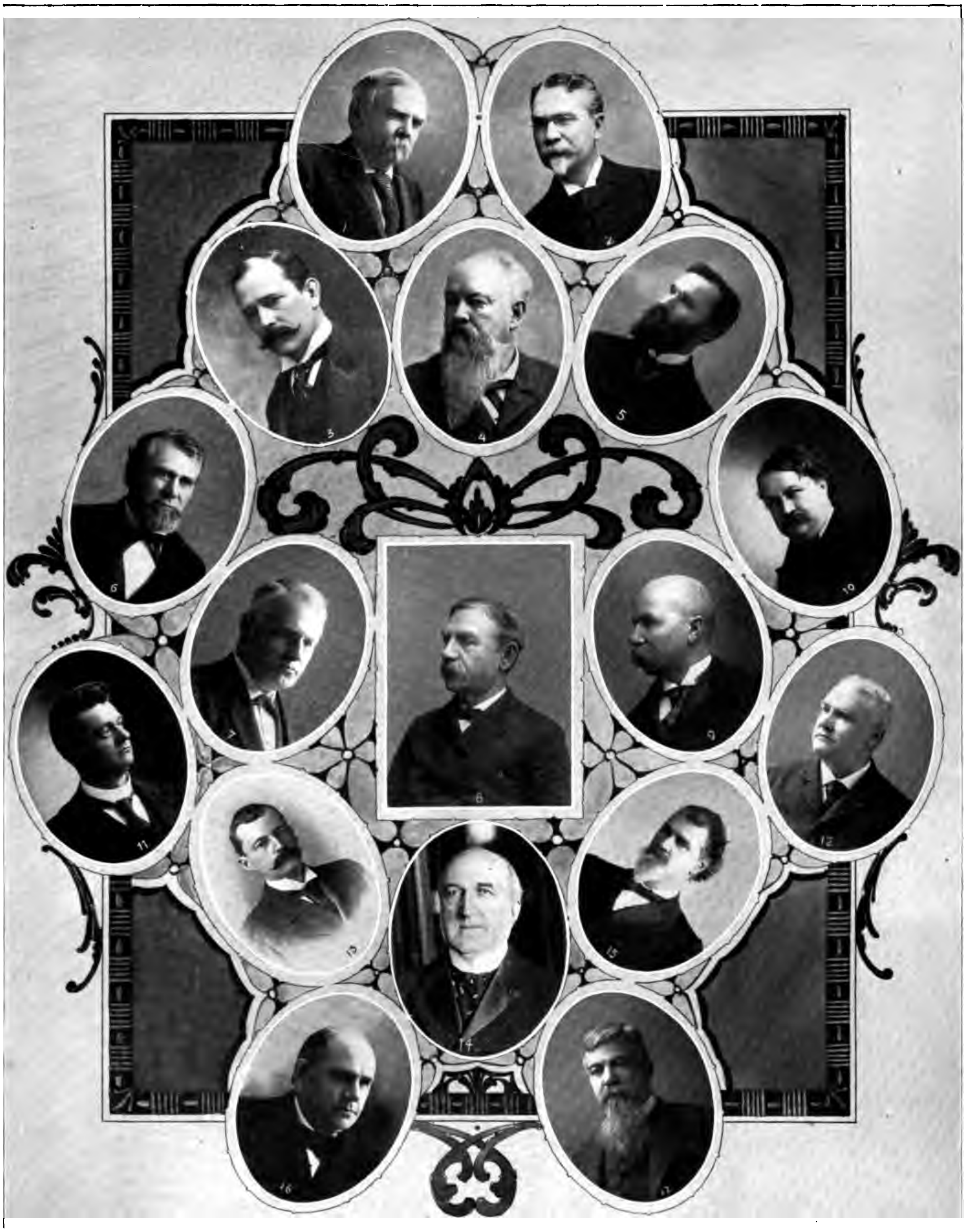

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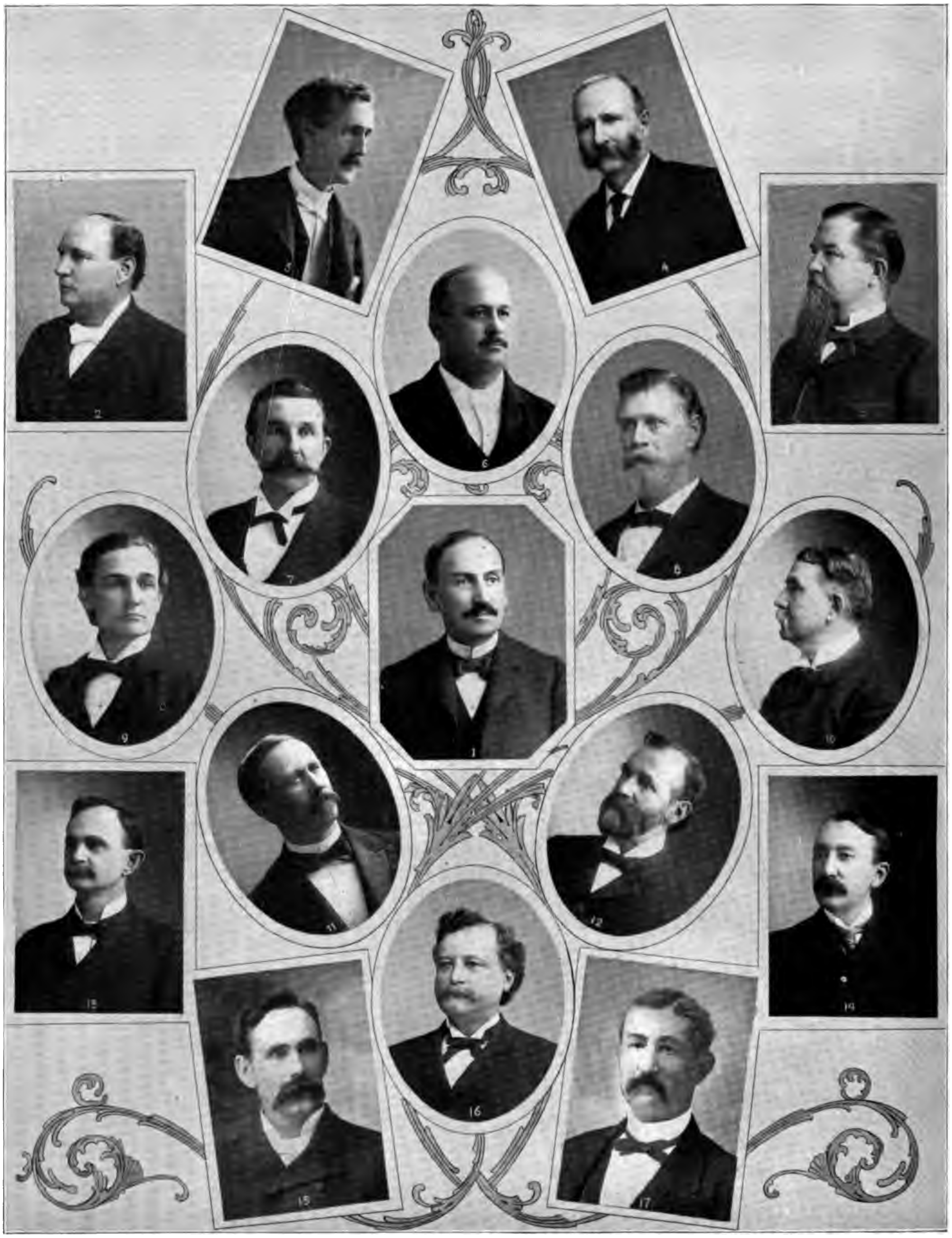

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SOME PROMINENT MEMBERS AND EX-MEMBERS, ETC.
(See page 244)

NOTE—Photographs were received too late to allow insertion in proper place.—ED.

PREFACE

THE comprehensive character of this work and its diversity of subjects, or, rather, its many phases of one general subject, make a preface necessary.

The motive of this publication is, of course, to benefit the cause for which the Association, of which the writer is Special Representative, has labored so persistently—to secure a treatment of the Mississippi River commensurate with its vast value as a gift of nature; to obtain for those who live on its alluvial lands just protection, which they rightfully have earned by heroic effort to protect themselves; to develop, for the good of the whole country, an empire of unmined wealth which Time has collected from the bowl of the Gods, and stored to lubricate the wheels of Industry. The conception of this work was mine—born of an enthusiasm which years of connection with this Great River and its rich alluvial lands, and years of more or less intimate relations with those who have striven so hard and labored so successfully in this cause, had fostered. I persuaded the Hon. Charles Scott, president of the Interstate Mississippi River Improvement and Levee Association, first to give it his official sanction, and, later, to accept it as a part of the work of the Association—this to give it standing as an effort for a public purpose and to eliminate the suspicion of private speculation. The public will pardon the statement which my pride induces me to make, that never once, even though assuming, in a certain sense, a responsibility for the character of the book, has Mr. Scott ever sought to advise regarding its contents. He gave an unreserved commendation of its purpose—for its proper preparation, he had faith in me. Thus the public can know where to place the blame for any shortcomings or deficiencies which may be found.

To make the book locally attractive and also of some good, perhaps, as an advertisement of our beautiful alluvial country, a concise illustrated review has been added. The review, brief as it is, discloses a pleasing picture of progress. Data of population and assessed valuations given fortify this statement. No attempt has been made to present other than bare and general outlines. More than usual space has been given of the great universities of Louisiana, all of which are located within the territory which this book describes.

The Police Juries of Louisiana, which are miniature legislative bodies in each parish, having been so active in levee matters, and so generous in aid of the movement to secure the support of a powerful public sentiment, it was my desire to include engraved groups of each, but it was soon apparent that it was next to impossible to secure complete groups of photographs, and, besides, space was limited, so that plan was reluctantly abandoned. Two or three groups, however, were made of such photographs as were sent to me. In a general way I have endeavored to give engravings of men who represent the levee, shipping, river and commercial organizations; also, the daily press, state officials, and a few others, which seemed to me to be appropriate. No engraving has been inserted for a cash consideration. No apology is tendered for the presence of any engravings—only regret is expressed at the absence of many which I would gladly have added. No doubt pardon will be granted me for making a departure, in a small way, by giving engravings of some of the strong men, living and dead, of our Crescent City—those who, as it were, link the past and the present in the upbuilding of our great Southern port—New Orleans—which, always interesting, prosperous and growing, is now on the threshold of a still brighter prospect.

THIS WE HOPE TO RESTRAIN—

AND THIS WE HOPE TO SEE UNHAMPERED IN ITS ENTRANCE INTO THE GREAT MISSISSIPPI RIVER.

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T. C. Catchings

THE MISSISSIPPI RIVER IMPROVEMENT

BY HON. T. C. CATCHINGS, OF MISSISSIPPI

THE exploits of Cortes in Mexico and Pizarro in Peru excited the attention of the European States to a degree which surpasses description. Spain and Portugal especially were fired with an enthusiasm for further conquest which knew no bounds. Those eager for adventure and military renown, and those whose imaginations were inflamed by the belief that exhaustless treasure awaited discovery, were alike active in organizing expeditions to explore the newly-found America.

One of these, led by Ponce de Leon, who had been a companion of Columbus, set out from Porto Rico in March, 1512, in search of the Fountain of Youth, whose waters were supposed to baffle time and disease and make youth perpetual.

It landed near St. Augustine, where it was set upon by the natives with intense fury. Those who were not slain were driven to their ships and returned to Cuba, where Ponce de Leon, who had been mortally wounded, soon died.

Bancroft says: "So ended the adventurer who had coveted immeasurable wealth and hoped for perpetual youth. The discoverer of Florida had desired immortality on earth and gained only its shadow." Other expeditions followed, which met with no better fortune.

In the year 1538 Hernando De Soto, one of the conquerers of Peru, surpassed in military renown only by Pizarro and Cortes, a Spanish nobleman of great wealth and influence, procured from the Emperor of Spain authority to undertake the conquest of Florida at his own expense. Attracted by the splendid promise of glory and riches, which such a movement commanded by so renowned and brilliant a captain offered, De Soto had no difficulty in gathering about him a band of bold, ambitious and courageous men, filled with enthusiasm and eager to follow wheresoever he might lead.

Mr. Irving says of this enterprise: "It was poetry put into action; it was the knight-errantry of the Old World carried into the depths of the American wilderness. The personal adventures, the feats of individual prowess, the picturesque descriptions of steel-clad cavaliers with lance and helm and prancing steed glittering through the wildernesses of Florida, Georgia, Alabama and the prairies of the far West would seem to us mere fictions of romance did they not come to us in the matter-of-fact narratives of those who were eye-witnesses and who recorded minute memoranda of every day's incidents." The expedition set sail from Havana May 12, 1539, and arrived in the bay of Espiritu Santo on the 25th of the same month.

It is needless to recount the many adventures of the expedition, but from the moment of its landing on the coast of Florida until its return four years later, its history is a story of continuous privation, suffering and sanguinary conflict. Engaged almost daily in combat with the natives, confronted constantly by dangers and difficulties of every conceivable nature, this gallant band of cavaliers forced their way, step by step, through the wilds of Florida, Georgia, Alabama and Mississippi, until they reached the banks of the Mississippi river in April, 1541, at a point near the present city of Helena. Because of its size they call it the "Rio Grande."

They crossed the river and pushed on westward, but were compelled by many disasters to return, and reached it again in May, 1542. Here on June 5, in his 42d year, Hernando De Soto, the first European who beheld the mighty and noble stream, worn out by incessant fatigue of body and mind, ended his career, and his companions, placing his body in a coffin made by hollowing out a piece of green oak, took it out to the middle of the river and sunk it in nineteen fathoms of water. Thinking to reach

Mexico, his survivors again marched westward, but were driven back by stress of circumstances, and returned to the river at a point near the mouth of the Arkansas.

Reduced in numbers to less than 350 men, they determined to abandon all further efforts of exploration, and constructed a small fleet of boats, in which they embarked on July 2, 1543. After passing through many dangers they reached the sea twenty days later, and beat their way westward until they reached the town of Panuco, on the Mexican coast, where they disbanded. It was through this expedition that we get our first knowledge of the Mississippi river, and its description given then will answer for to-day.

Monette says: "The lapse of three centuries has not changed the character of the stream. It was then described as it now is, as more than a mile in width, flowing with a strong current, and by the weight of its waters forcing a channel of great depth. The water was described as being always muddy, and trees and timber were continually floating down the stream."

While Spain was attempting the conquest of the Southern country, and England that along the New England and Middle Atlantic coast, France had gained a foothold in the extreme North, and had founded the city of Quebec as early as 1608.

The motive which impelled her was very different, however, from that which controlled other powers.

Bancroft truly says: "It was neither commercial enterprise nor royal ambition which carried the power of France into the heart of our continent. The motive was religion." We therefore naturally find that the Jesuits were always on the outpost of French progress. "The history of their labors is connected with the origin of every celebrated town in the annals of French America. Not a river was entered, not a cape was turned, but a Jesuit led the way."

In 1669 Father Allouez learned from the tribes of Indians on the southern shores of Lake Superior of a great river further to the west called by them the "Mesasippi" or Great River.

It was ascertained "that it flowed neither toward the north nor toward the east," but not to what point its course lay, nor into what sea it discharged.

In 1673 an expedition to discover and explore this great river was organized. It was put in charge of M. Joliet, of Quebec, and Father Marquette, who had aided in establishing a mission at the Sault St. Marie.

The latter, by reason of his familiarity with the natives and their great attachment to him, was well fitted to lead such an enterprise. "Such was the veneration of the savages for this good man, that for years after his death, when overtaken in their frail bark canoes by the storms on Lake Michigan, it is said that they called upon the name of Marquette, and the winds ceased and the waves were still."

They turned from Lake Michigan into Green Bay, where they entered and ascended Fox river. Thence they crossed the portage to the Wisconsin, and descending it, reached the Mississippi June 17, 1673.

They passed the mouth of the Missouri (the Pekitanoni of the Indians), the confluence of the Ohio, and down the river 1,100 miles below the point at which they had entered it. They then returned and made known their discovery amidst great rejoicing. Until then no white man had seen the Mississippi since the fatal expedition of De Soto, one hundred and thirty years before.

La Salle, in 1679, next entered the river, but he crossed the portage from Lake Michigan into the Illinois, and went down that stream. He caused explorations to be made as far up as St. Anthony's Falls, and in 1682 descended to the Gulf of Mexico.

He named the river "St. Louis," and the country, "Louisiana." Returning to France, he organized a colony and sailed for the mouth of the river, but failed to find it, and landed at the Bay of Matagorda. While attempting to reach the settlement which he had founded on the Illinois before returning to France, he was slain by his companions. In 1689 De Tonti descended to the mouth of the river in search of La Salle, but hearing nothing of him regained the Illinois country. Owing to continuous Indian wars, no further discoveries were made until about the treaty of 1700, with the five nations, which is described as follows: "A written treaty was made, to which each nation placed for itself a symbol—the Senecas and Onondagas drew a spider; the Cayugas a calumet; the Oneidas a forked stick, and the Mohawks a bear." After this colonies began to enter the valley both from the North and the South.

Towns and trading posts were established, especially in the Illinois country, and as early as 1712 land titles and deeds came into use to designate private acquisitions. By 1720 a very considerable trade had grown up between the upper and the lower settlements.

Iberville established a post at Biloxi in 1699, and made repeated explorations of the lakes, bayous and tributaries of the lower river.

The movements of the French had attracted the attention of the English to the Mississippi valley, and they dispatched a man-of-war about this time to explore the mouths of the river. Bienville, a subordinate of Iberville, while sounding the channel a few miles below the site of New Orleans, met this vessel and threatened resistance if it did not leave. The vessel departed, though under protest, and the point at which it turned is known to this day as the "English Turn." New Orleans was founded in 1718, and a survey of the passes by Pauger, a royal French engineer, having shown that shipping could be brought up the river, it was made the principal depot and capital of Louisiana.

The commerce of the valley in 1745 is thus described: "The trade between the northern and southern portions of Louisiana had greatly augmented, as well as that from New Orleans to France and foreign countries. Regular cargoes of flour, bacon, pork, hide, leather, tallow, bear's oil and lumber were annually transported down the Mississippi in keel boats and barges to New Orleans and Mobile, whence they were shipped to France and the West Indies. In their return voyages these boats and barges, from New Orleans and Mobile, supplied the Illinois and Wabash countries with rice, indigo, tobacco, sugar, cotton and European fabrics. The two extremes of Louisiana produced and supplied each other alternately with the necessaries and comforts of life required by each respectively. The mutual exchange of commodities kept up a constant and active communication from one end of the province to the other. Boats, barges and pirogues were daily plying from one point to another, freighted with the rude products of a new and growing country. The great highways of commerce were the deep and solitary channels of the Mississippi and its hundreds of tributaries."

In the lower country rice, indigo and tobacco were the chief crops at this time. In 1751 sugar cane began to be cultivated. The first sugar mill was erected in 1758 and proved so remunerative that many others were put up, and by 1760 sugar cane had become one of the staple crops. Cotton was grown, but only in limited quantities for domestic consumption, because of the difficulty in separating the lint from the seed. About 1752 a cotton gin was invented by M. Dubreuil, which so facilitated the process that cotton growing became more extensive. But it was not until the invention in 1807 by Whitney of the saw cotton gin that the impulse to cotton growing was given, which has made it the chief business of many portions of the South.

Only the large plantations, however, could afford a gin, so public gins were set up, upon which the crops of the small planters were ginned.

In the Mississippi territory, laws were passed requiring all cotton to be ginned within four months from its delivery. "Cotton receipts" were given, and as early as March, 1806, they were made negotiable by law, whereby they became domestic bills of exchange and answered the purpose of a circulating medium.

A continued struggle had been progressing for supremacy in the Mississippi valley between France, England and Spain, with various and shifting results, which need not be recited here.

By the treaty of 1783, Great Britain relinquished to the United States everything east of the Mississippi, from its source to the 31st parallel of North latitude, and at the same time it ceded to Spain everything east of the Mississippi and south of the 31st parallel. France, in 1763, had ceded to Spain all Western Louisiana, including the island of Orleans.

Thus the river for the last 300 miles flowed entirely through Spanish dominions, and Spain claimed the exclusive right to the use of that portion, and imposed heavy duties on all produce brought down. They were enforced by excise officers, supported by the military, and every boat was required to land and submit to these revenue exactions.

This was the only outlet for the rapidly-growing West, and the American people demanded free navigation as a natural right, as well as through the treaty with Great Britain.

In 1788, Congress declared "that the free navigation of the Mississippi is a clear and essential right of the United States, and that the same ought to be considered and supported as such."

Finally, Spain, by the treaty of 1795, stipulated "that the whole width of said river, from its source to the sea, shall be free to the people of the United States."

France had never approved the cession to Spain of Western Louisiana, and Napoleon, by the treaty of Ildefonso, confirmed in March, 1801, required it from Spain. Being involved in war with England, however, and apprehensive that he could not hold it, by the treaty of 1803, he sold it to the United States. When the treaty had been executed, he said: "This accession of territory strengthens forever the power of the United States, and I have just given to England a maritime rival that will sooner or later humble her pride."

From this time on, and especially after the introduction of steam power, the commerce of the river rapidly increased, and to-day its valley is the center of wealth, population and political control.

THE MISSISSIPPI RIVER LEVEES.

A few miles above Cairo the Mississippi river breaks through a spur of the Ozark mountains. At some time in the remote past an estuary, which was approximately 600 miles long and from 25 to 80 miles wide, extended from the Gulf of Mexico to this point. It has gradually been displaced by the sediment brought down by the Mississippi river and its tributaries. This sediment was of course deposited the moment the waters which had carried it along in suspension reached this arm of the sea. Hence the building up of the alluvial lands of the lower valley began at the northern end of the estuary and, step by step, marched down to the sea.

The comparative elevations of the land and sea are such that at the point where the Mississippi river cut through the mountain spur above Cairo it must have had a fall of several hundred feet. It necessarily followed from this that the vast quantities of sediment deposited by the floods, which perpetually discharged into the estuary, would in time drive it back and supplant it by lands which would be built up far above the level of the sea.

The lands which ousted the estuary in the manner described gave birth to a dense and luxuriant growth of vegetation as soon as they had been built up to an elevation above the sea level. The waters of the river being insufficient to cover all the lands so created, or indeed, any considerable portion of them, except during the existence of great floods, were naturally concentrated under normal conditions into a channel of their own making, and through this channel made their exit to the sea. When the floods came they found this channel insufficient, and, overtopping its banks, spread out over the valley in a thin sheet of water, varying in depth from a few inches to a considerable number of feet, where it remained until the supply from above ceased, when it was gradually drawn back into the channel, except as to certain parts of the extreme lower valley whence it could otherwise more directly find a way to the Gulf.

The water of the river is more heavily charged with silt or sediment during flood periods than under normal conditions. This sediment is maintained in a state of suspension altogether by the motion of the water. From this it follows that when from any cause the velocity of the water is reduced it must drop some part of its load, and when it is entirely checked it must drop the whole of it. It is by virtue of this law that the mouths of all silt-bearing streams become obstructed by bars, which seriously interfere with commerce. The Eads jetties were constructed to remove the shoaling of the South Pass of the Mississippi river resulting from the principle stated.

When the floods come and the channel can hold no more water they can only make room for themselves by escaping over its banks. The velocity of the water outside of the channel is much less than the velocity of that which remains in the channel, and it therefore begins at once to part with its supply of sediment. This operation is hastened by the obstruction created by the trees and undergrowth. As the velocity is thus checked, naturally the coarser and heavier particles of sediment are first dropped, and the remainder is gradually parted with, until when the water has gone a considerable distance it becomes comparatively clear. For this reason the banks of the Mississippi, and of all silt-bearing streams, are higher than the lands further back. The land slopes away from the banks of the river so that the fall is about six or seven feet to the mile. It is thus seen that the river when left to itself was constantly building its banks higher and higher, and so making its channel more and capable of holding the floods. In time if man had not made his appearance, and by his operations seriously interfered with the processes of nature, they would slowly but surely have raised the banks of the river until overflows would have become extremely rare. In building levees therefore to prevent the escape of the floods, man is but imitating nature.

The lands of the lower Mississippi valley, which comprise about 30,000 square miles, are so extraordinarily fertile that they have attracted attention from their earliest discovery, and much speculation, theorizing and contention have for long been indulged in as to the best method by which they can be protected from inundation so that they can be subjected to the uses and needs of man. If artificial banks, which are called levees, can be made high and strong enough to restrain the floods, they furnish not only a sure method but infinitely the cheapest. The earliest settlements in the valley having been made in the extreme southern portion of it, efforts to secure protection against the floods first began there. In 1717 a levee was built to protect the city of New Orleans from overflow. In 1735 DePratz says that "the levee extended from English Bend, twelve miles below, to thirty miles above, and on both sides of the river." In 1743 an ordinance was promulgated "requiring the inhabitants to complete their levees by the 1st of January, 1744, under a penalty of forfeiture of their lands to the crown." The levee building of those days was a small affair compared with that now going on. Its purpose was solely to protect the narrow strips of high land along the banks of the river, as only these were occupied. This was effected by small levees along the river front and cross-levees running back to the lower and uninhabited lands. As the floods were allowed to roam at will over every other part of the valley it was both easy and inexpensive to construct levees sufficient to accomplish the very limited results intended. Before many years had elapsed, however, the richness of these alluvial lands had attracted quite a large population, and the levees were rapidly extended until by 1858 nearly the whole basin was leveed. Between 1861 and 1865, neglect and the ravages of war destroyed the greater part of this work, but with the return of peace it was promptly taken up again and has ever since been prosecuted with more or less vigor. Until 1882 every dollar expended on this work had been raised by taxation of those dwelling in the valley. In 1879 the Mississippi River Commission was created by Congress and charged with inquiring into the best methods of improving the river for navigation purposes, and for the prevention of overflows. In 1882 it allotted $1,300,000 to be expended in closing the crevasses made in the levees by the great flood of 1882. This was the first money ever expended by the Government in levee building. This act of the Commission greatly excited the hopes of the people of the valley and aroused them to efforts which may well be described as stupendous. Since that date about $27,000,000 have been expended in the construction of levees. Of this the Government has provided about $12,000,000 and the people of the valley about $15,000,000. When the flood of 1897 broke upon us there were about 1,300 miles of levees. None of these levees were of the dimensions regarded by the engineers as necessary to withstand such a flood as that of 1882, and a considerable part of the St. Francis front was not leveed at all. We had hoped that such a flood as that would not come, at least until we were better prepared to cope with it, but we were disappointed. The flood of 1897 exceeded that of 1882. Judged by duration and height combined it has no equal. On March 25th it reached its highest stage at Cairo, which was 51.6 on the gauge. The highest gauge reading before recorded was 52.02, reached by the flood of 1883 on February 27th. That flood was so short, however, that in no other respect can it be compared with that of 1897. The magnitude of the flood of 1897 can best be appreciated from the fact that it practically stood for thirty-three days at Cairo at and over 49 feet on the gauge. The levee system being very much stronger and more extensive than ever before, the flood elevation all along the river was greater than during any previous floods. This, of course, was to be expected. The levees along the St. Francis basin were so incomplete that in many places the water broke through or ran over them. Several crevasses occurred on the Arkansas side above the mouth of the White river, and four or five along the front of the Yazoo basin. Between the mouth of the White river and a point nearly opposite Vicksburg where the Briggs crevasse occurred, there was no break on the west side. One other break, a nearly harmless one, occurred in the Tensas line, and a small one, which was promptly closed, occurred just below Baton Rouge. The total length of levee destroyed was 8.7 miles, being but .63 of 1 per cent. of the whole work.

The increasing strength of the levees will be best understood by a comparison of the loss inflicted upon them by previous floods. In 1882 the total number of crevasses in the levees was 284, aggregating 56.09 miles in width. In 1883 the number of crevasses was 224, with an aggregate width of 34.1 miles. In 1884 the crevasses numbered 204, aggregating 10.64 miles in width. In 1890 the total number of crevasses was 23, aggregating 4¼ miles in width.

In 1897 but little over one-third of all the alluvial lands from Cairo to the Gulf were inundated. This includes the lands in the St. Francis basin, which should not be taken into account in estimating the protection afforded by the levee system, inasmuch as quite one-third of its front had not been levied at all.

No man can say that our levee system, incomplete though it is, has not afforded a vast amount of protection, or justly draw from the experience of the past the conclusion that it is not within the power of man to build levees strong enough to absolutely restrain the floods. To my mind the work presents no engineering difficulties, and supported by ample funds, I have no doubt that it would be speedily finished. All of the engineers who have ever been connected with it, whether local or members of the Army Corps, are of one mind in this regard. If protection cannot be afforded by levees, it cannot be had at all, and if it cannot be had all of the back lands—and they constitute the greater part—must be abandoned. If they must be subjected to perpetual recurring overflows they cannot be inhabited. The losses accompanying overflows, the uncertainty of making crops after they have subsided, the sickness likely to follow them, and the great inconveniences always attending them would gradually, perhaps, but nevertheless surely, cause their abandonment. The minimized population and production thus caused, together with the interruption of traffic, would certainly drive the railroads out. Thoughtful men understand all this, and, undeterred by croakers and occasional disasters, will press forward bravely in the future, as they have done in the past, and never lay down their arms until the battle has been fought and won.

Much has been said about the outlet plan. I do not intend to point out the many serious objections to it. It is well, however, to invite attention to one or two facts. The first point below Cairo where a real outlet can be had is at the head of the Atchafalaya river. By real outlet I mean such a drawing off of water from the main channel as that it will not return to it again, but find its way to the sea by some other route. It is a misnomer to speak of the overflow of water into the St. Francis basin or the Yazoo basin as an outlet, inasmuch as it returns to the river again, in the former case at the mouth of the St. Francis river, and in the latter at the Vicksburg hills. In my judgment, except in the case of floods shorter and quicker than any I have knowledge of, so that the flood wave would pass off before the overflow water in such basins as I have referred to could return to the river, no relief can be had in that direction. Even real outlets do not give appreciable relief above them. In 1890 a crevasse occurred in the levee at Nita, La., on the east bank, about 60 miles above New Orleans. It was 3,000 feet wide and 15 feet deep, and actual measurement showed that it carried off 400,000 cubic feet of water per second, which equaled 30 per cent. of the entire discharge of the river immediately above the crevasse. Not one drop of water going through it ever returned to the river. Here we had an ideal opportunity to test the efficacy of outlets as a means of lowering the flood surface. The flood elevation was lowered a foot and a half immediately below the crevasse, and one foot at New Orleans, 60 miles below, while at Plaquemine, 50 miles above, no effect whatever was produced.

Levee building offers the only relief according to my understanding of the problem, though, being but a layman, I would not set my judgment up against the engineers, and am willing to follow whithersoever they lead. The magnitude of the work, however, is such that it can only be accomplished by the strong arm and abundant resources of the Federal Government, and the dwellers in the Great Valley should be satisfied with nothing short of absolute National control of the whole question. Abundant grounds could be assigned if space and time would permit it, upon which they can safely base the claim that it is the duty of the Government to come to their rescue. If the General Government should assume entire control and supply its engineers with requsite means, we should soon see magnificent lines of levee, properly located, carefully constructed, constantly repaired and guarded, behind which the people of the valley could make their homes and sow and harvest their crops in peace and safety.

N. C. Blanchard

THE MISSISSIPPI RIVER

SOME CONSTITUTIONAL AND LEGAL ASPECTS OF THE QUESTION

BY JUSTICE N. C. BLANCHARD, OF LOUISIANA SUPREME COURT

THE Mississippi river is the great sewer of our country. It drains the waters that fall upon more than twenty-five States of the Union. Even the rain that falls upon the western portion of the State of New York finds its way to the Gulf of Mexico through the soil of Louisiana. Steamboats have penetrated as far as the town of Olean, in the State of New York, away up on the Alleghany river, which in turn pours into the Ohio, which in turn empties into the Mississippi and then into the Gulf.

And far from that point—away to the westward beyond Fort Benton, in Montana, or to the tops of the Rocky Mountains—this great drainage basin extends.

From above the Canadian line on the north, to the sun-kissed waves of the Mexican gulf on the south, the rainfall of nearly one-half of the entire northern portion of the American continent finds its way through the State of Louisiana to the sea.

The Mississippi river is too great a national feature of our country to be handled by any State or aggregation of States. No other power than that of the National Government is potential enough to take it in hand and make it perform its two-fold function of affording a national highway for the commerce of the Republic and of discharging its flood waters safely into the Gulf of Mexico.

The river is the property of the Federal Government. It is its property in the sense that its jurisdiction over it is paramount to that of the States which border upon it. The States cannot say what shall be done with the river or to it, nor how it shall be treated. They are not permitted to divert it, nor change its course, nor to injure or interfere with its navigation.

Suppose Congress should withhold its hand and its money, and do nothing adequately towards restraining the flood waters of the river and preventing inundations. In default of such action by the General Government the right of self-preservation arises, and the States and individuals in the valley are themselves entitled to take the matter in hand and resort to such means as they may devise to control the flood discharge of the river for their own protection and for the protection of their property. Suppose, then, that the dwellers in the lower valley of the river, despairing of adequate Congressional action, should resort to the plan of opening innumerable outlets all along the line of the river in every direction available, on the idea advanced by some, but denied by the best authority, that outlets contribute to the prevention of floods. They might so dissipate and scatter the waters of the river by means of these outlets that the navigable character of the great stream might be seriously impaired, if not entirely lost or destroyed. Suppose they were attempting such a thing, would not the strong arm of the Federal Government be exerted to prevent it? Would not Congress say: "You shall not construct works or so treat the Mississippi river as to destroy its navigable character?" Undoubtedly. When Mr. Jefferson acquired the territory known as Louisiana from France the great and controlling idea actuating that acquisition was that the American Union should control the entire country through which flows the Mississippi river, in order that the river might be forever open as a great highway for the commerce of the world.

The United States, then, is interested in preserving the navigable character of the river, and must necessarily check, by legislation or other means, the construction of works that may be designed to destroy, or which might have the effect of destroying, its navigation. But could the Government do this without, in justice and fairness, assuming the obligation itself of so curbing and restraining the river as to give a safe and easy discharge of its flood waters? The question admits of but one answer: It could not.

It has been doubted by some that there is constitutional authority in Congress to appropriate public funds to prevent the floods of the river.

The constitutional authority to appropriate money for purposes of channel improvement of the river to benefit navigation is not denied, under the power vested in Congress by the Constitution to regulate commerce; but it has been denied that there is warrant in the Constitution for Congress to go further and appropriate money for the direct purpose of restraining the flood waters of the river.

While somewhat of a strict constructionist of the Constitution, I have no trouble in deducing authority from that instrument justifying Congress in appropriating funds for the two-fold purpose of improving the navigation of the river and of restraining its flood waters.

An enemy invades us. Our people fly to arms. Points of defence are strengthened. The eye of strategy selects other points to be fortified and defended. Congress votes the money and immediately long lines of breastworks guard our frontier where attack is apprehended.

But here is an enemy who comes in the form of raging waters, sweeping down in resistless might from the North upon the sunny valleys of the West and South, bringing devastation, destruction, death. He raids through the country, rioting in ruin, and millions, panic-stricken, flee at his approach, leaving their all to be swallowed up in the wild vortex of destruction. The wasting presence lasts but a couple of months, but in that time there has been a destruction of property, present and prospective, equal in value to many millions of dollars. (*See engravings of crevasses.*)

It is the duty of Congress to say to these people who have so often experienced the disasters of inundation that, even as we would erect breastworks on our frontier to repel the threatened invasion of a warlike foe, so will we build levees along the great river to beat back its surging waters, threatening destruction well-nigh equal to what a human enemy could inflict.

But, it may be argued, the delegation of power to Congress to "repel invasions, to protect the States against invasion," has reference to a human foe. I grant that this is the usual and ordinary meaning or significance given to the term, and it is likely that the framers of the Constitution had in contemplation a human foe when they inserted that clause. The connection, too, in which it is used gives additional weight to the argument. But still, the power conferred by the words "repel invasions," by the clause "The United States * * * shall protect each of them (the States) against invasion," is a general one, and might well and reasonably include defending the country against danger or harm of any kind.

Suppose some monster, like the fabled dragon of ancient times, were to rise up out of the deep and invade the land, spreading devastation, destruction, pestilence and death around him. Does any one doubt the constitutional power and duty of Congress to "repel" his invasion, to bring the strong arm of the Government to bear against him, to make war upon and kill and destroy him? I think not. And yet, there are those to be found who deny to Congress the power to "repel" the invasion of waters, to throttle this monster of inundation whose periodical visitation of the fairest portion of our country is but the recurring occasion for a carnival of waste, ruin, rapine.

The Constitution (Art. IV, Section 3) provides:

"That Congress shall have power to dispose of and make all needful rules and regulations respecting the territory or other property belonging to the United States."

In the Gratiot case (14 Peters, 537) the Supreme Court of the United States, construing the above clause, said:

"The term 'territory,' as here used, is merely descriptive of one kind of property, and is equivalent to the word 'lands.' And Congress has the same power over it as over any other property belonging to the United States; and this power is vested in Congress without limitation."

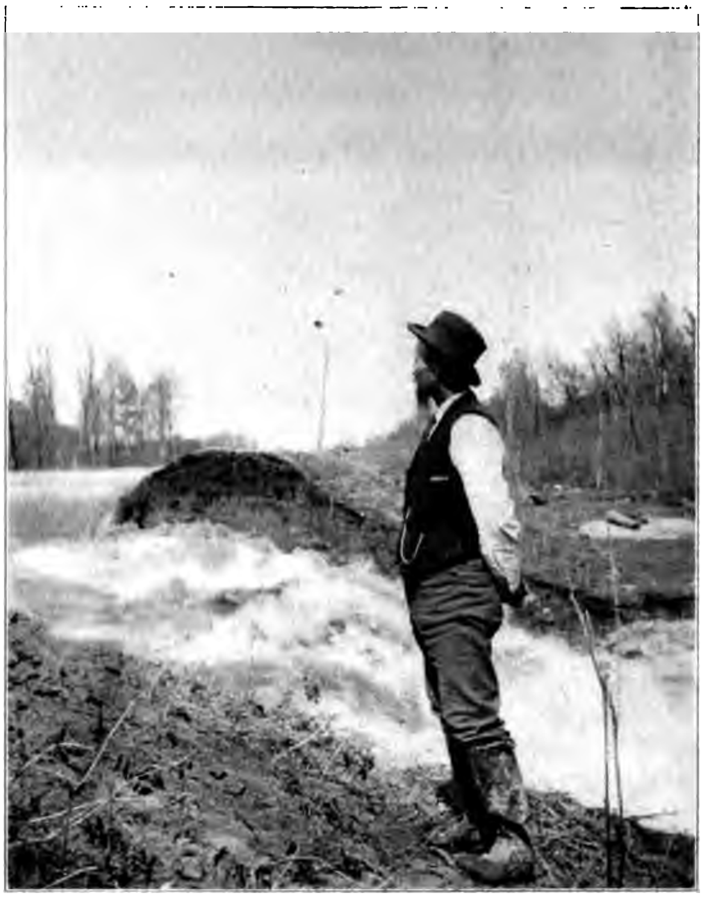
In the case of McCulloch *vs.* Maryland (4 Wheaton, 422) the Chief Justice, as the organ of the court, speaking of this clause of the Constitution and the powers of Congress growing out of it, applies it to territorial governments, and says all admit their constitutionality.

Story says (volume 2, page 228):

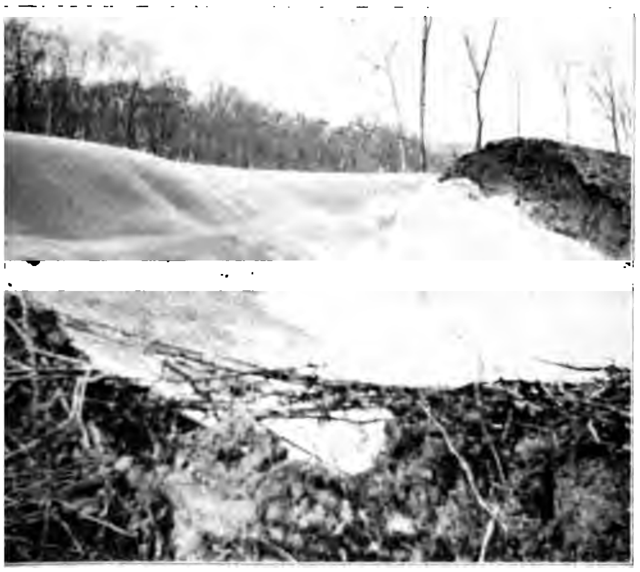
"No one has ever doubted the authority of Congress to erect territorial governments within the territory of the United States, under the general language of the clause 'to make all needful rules and regulations.'"

He continues:

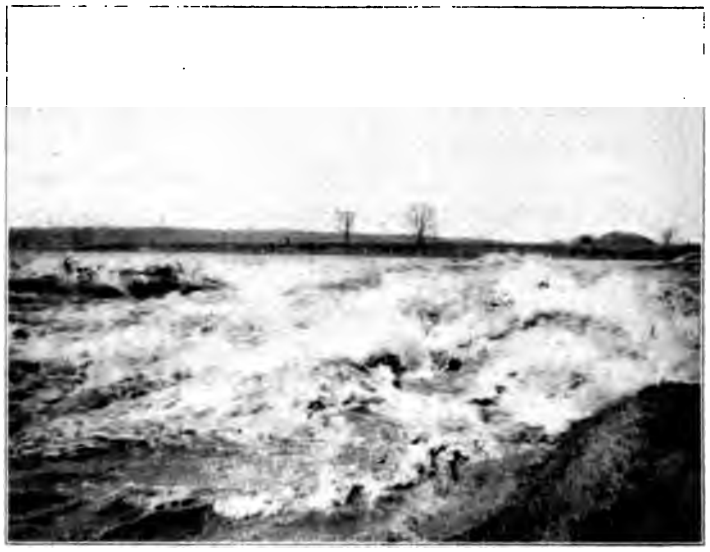
"The power is not confined to the territory of the United States, but extends to 'other property belonging to the United States'; so that it may be applied to the due regulation of all other personal and real property rightfully belonging to the United



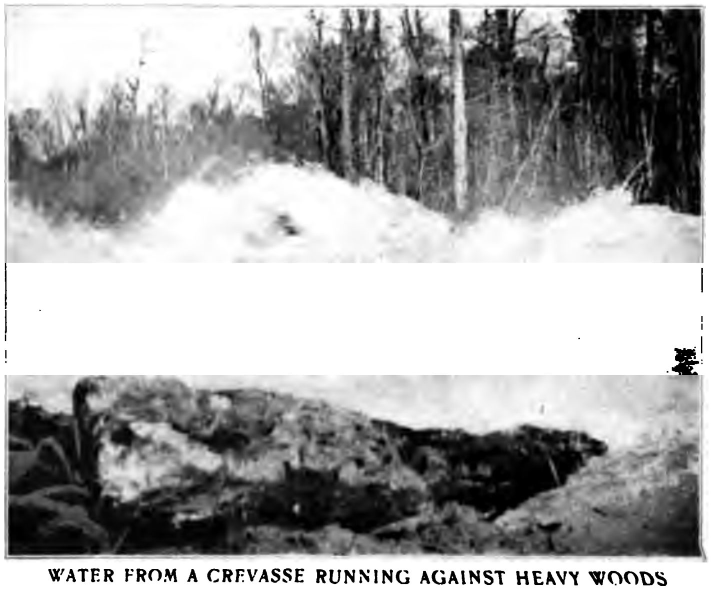
BEGINNING OF A CREVASSE



CREVASSE TWO HOURS AFTER BREAKING OF LEVEE



CREVASSE AT ITS MAXIMUM



WATER FROM A CREVASSE RUNNING AGAINST HEAVY WOODS

States. And so it has been constantly understood and acted on."

Now, then, if the Mississippi river is the property of the General Government, it is as much subject to "regulation" as the landed property or territory of the United States. And this power to regulate includes curbing, controlling, restraining the river within its own proper metes and bounds by means of levees, dikes, or other works, as Congress may, in its discretion, see proper to adopt, for, in the language of the Gratiot case, "this power is vested in Congress without limitation."

But it may be denied that the Mississippi river is the property of the United States in the sense that Congress may, under the power to regulate, direct the construction of works to restrain its waters within their proper channel.

The Mississippi river is a great national highway. It belongs as much to the United States as would a great trunk line of railroad that had been constructed, stocked and was being operated by the Government. In the Act of Congress enabling the people of Louisiana to form a constitution there is a provision that the State Convention shall "pass an ordinance providing that the river Mississippi and the navigable rivers and waters leading into the same or into the Gulf of Mexico shall be common highways and forever free, as well to the inhabitants of the said State as to other citizens of the United States." And in the Act for the admission of Louisiana, the above provision as to the navigation of the Mississippi is made one of the fundamental conditions of admission. Similar conditions were likewise imposed upon the admission of the States of Mississippi, Missouri and Arkansas.

In the case of The United States *vs.* The New Bedford Bridge (Woodbury & Minot's Reports, 421), Mr. Justice Woodbury used the following language:

> "For purposes of foreign commerce and of that from State to State, the navigable rivers of the whole country seem to me to be within the jurisdiction of the General Government, with all the powers over them for such purposes (whenever they choose to exercise them) which existed previously in the States or now exist with Parliament in England."

In the case to Corfield *vs.* Coryell (4 Washington Circuit Court Reports, 379), Mr. Justice Washington said:

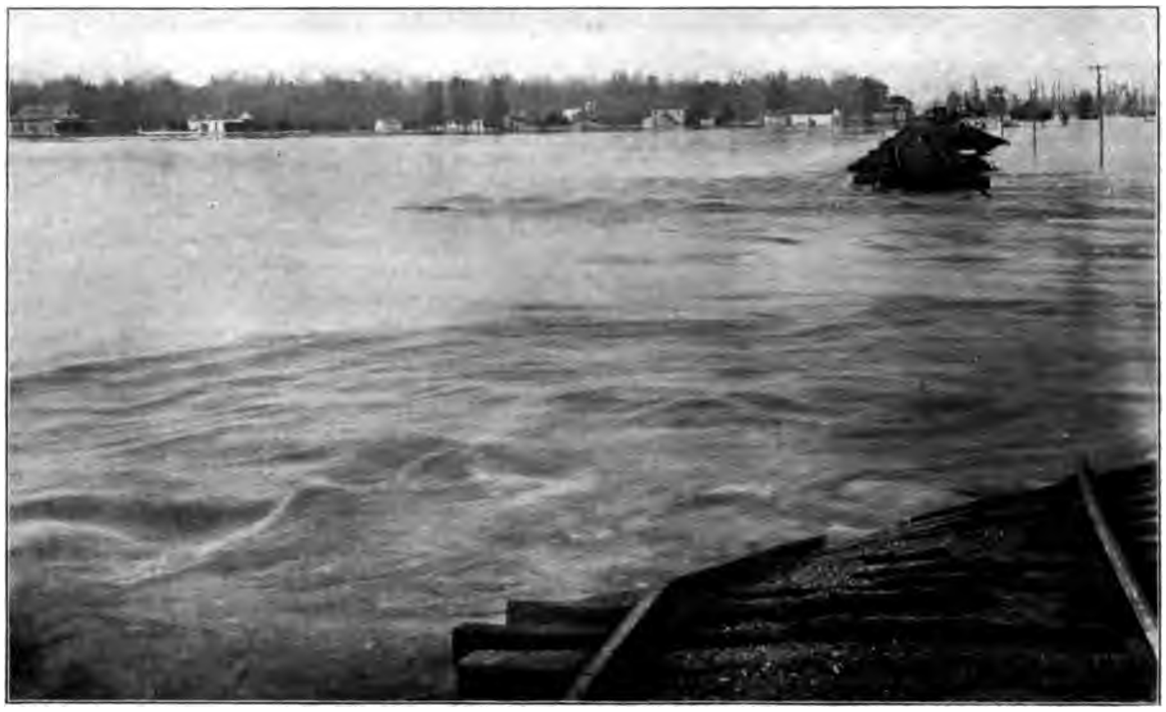
> "The Grant to Congress to regulate commerce on the navigable waters belonging to the several States renders those waters the public property of the United States for all purposes of navigation and commercial intercourse, subject only to Congressional regulation."

And in the case of Gilman *vs.* Philadelphia (3 Wallace, 724), it was said:

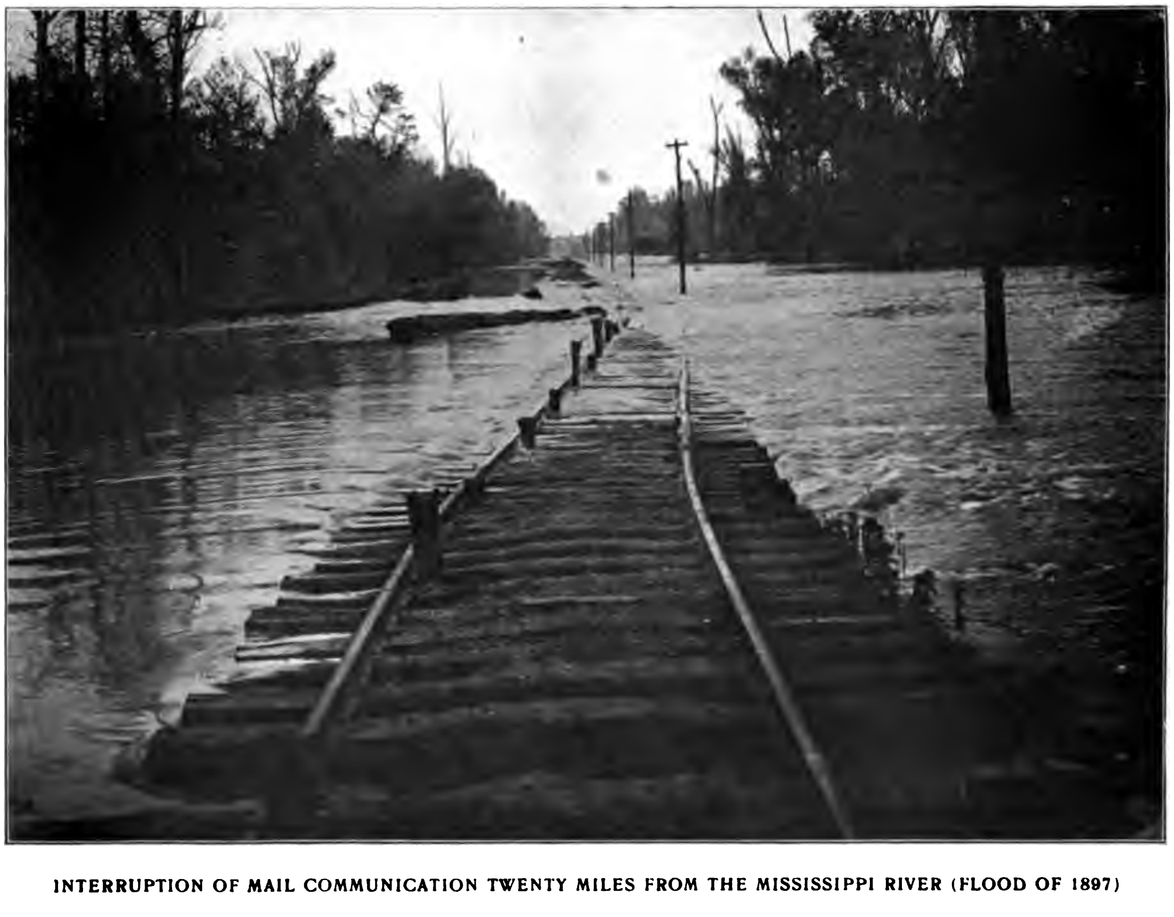
> "The power to regulate commerce comprehends the control for that purpose and to the extent necessary of all the navigable waters of the United States which are accessible from a State other than those in which they lie. For this purpose they are the public property of the nation, and subject to all the requisite legislation of Congress. This necessarily includes the power to keep them open and free from any obstruction to their navigation, interposed by the States or otherwise; to remove such obstructions when they exist, and to provide by such sanctions as they may deem proper against the recurrence of the evil, and for the punishment of offenders. For these purposes Congress possesses all the powers which existed in the States before the adoption of the National Constitution, and which have always existed in the Parliament in England. It is for Congress to determine when its full power shall be brought into activity, and as to the regulations and sanctions which shall be provided."

It cannot, therefore, be doubted that the river, for all practical purposes, is the property of the General Government and subject to its "regulation," whether as respects prescribing rules for governing the commerce and traffic which make use of it as a highway, or as respects controlling it in the sense of denying the dominion and jurisdiction of the States, or other powers; or as respects preventing the river from rising up out of its customary channel and spreading over the country.

It may be objected by some that should the Federal Government provide the ways and means for the construction of an adequate levee system for the protection of the alluvial valley of the river, inasmuch as these levees will have to be constructed on the banks over which the jurisdiction of the States respectively extend, contention may arise between the State government and the National Government on this point; that the State government might deny the right of the National Government to control the levees, to protect them after constructing them, and that the question thus raised may become



INTERRUPTION OF MAIL COMMUNICATION TEN MILES FROM THE MISSISSIPPI RIVER (FLOOD OF 1897)



INTERRUPTION OF MAIL COMMUNICATION TWENTY MILES FROM THE MISSISSIPPI RIVER (FLOOD OF 1897) a fruitful source of trouble between the sovereignty vested in the State and that reposing in the Federal Government.

That trouble may ever arise on this score is a conjecture so remote as to be unworthy of serious consideration. What there is may be easily obviated by the insertion in the act of appropriation of a clause that there should be no expenditure of money within the territorial limits of a State until the State shall have ceded to the National Government the right to control and protect the public works to be constructed.

Louisiana has already done this in Art. 215 of her Constitution of 1879, and Art. 240 of her Constitution of 1898 (the present one). Full authority is given the National Government to construct such public works along the Mississippi river as Congress may see proper to order, and the control of the same after their construction is ceded to the National Government.

The State of Louisiana, in incorporating this grant of authority in her organic law, recognized what is now generally conceded, viz, that there is no power competent to handle the questions presented by this great river save that of the Federal Government. No State can do it:

First. Because the work is too vast, too costly for any State through which the river runs to undertake it.

Second. Because any State attempting it would be circumscribed by its own territorial limits.

Third. Because the river, being the property of the United States, Congress alone has power under the grant to "make all needful rules and regulations respecting the territory and other property belonging to the United States," to say what works shall be done or plans adopted for its regulation.

Under the authority "to establish post-offices and post-roads" the Government of the United States has established thousands of the former in the alluvial valleys of the Mississippi and its tributaries, and provided a perfect network of the latter. Daily over thousands of miles of roadway and railway and water-way in the great valley is the United States mail carried, supplying innumerable post-offices and affording facilities indispensable for the dissemination of intelligence, for the diffusion of the market reports, the crop and commercial reports, and the news generally so absolutely needed for the welfare, the happiness and the prosperity of the people and the country.

Millions of money, besides great labor and much valuable time, have been expended in building up and perfecting this system, which in the normal state of the country moves with the precision, ease and regularity of well-ordered machinery. But periodically the great river swells up out of its banks and becomes a great inland sea, producing an abnormal condition of affairs, and disarranging, stopping, destroying for the time being the postal service, the transportation and delivery of the mails.

On our statute-books, as the enactments of Congress, stand stringent penal laws denouncing penalties against any and all who shall willfully impede, interfere with or stop the mails; and the courts of the United States hold sittings all over the valley to inforce these laws.

But here is a great convulsion of nature, as it were, that stops not one mail but a thousand, that breaks up not one post-office but hundreds, and against which the courts and the criminal laws for the protection and security of the mails avail nothing. (*See engravings.*) To prevent a continuance of this is the strong arm of the Government powerless? No. Scientific, wise, experienced men, who have made a study of the river and its phenomena, of the laws of its currents, and of the conditions that affect it, say no! They have pointed out how these destructive floods may be avoided, and thus how the mails of the United States, their carriage and delivery, may be protected.

Now, then, does any one doubt that from the authority "to establish post-offices and post-roads" flows not only the power but the duty to protect them? No reasonable man can doubt it. No lawyer will hesitate for an instant to declare that the power to protect is incidental to the power to establish. The constitutionality of the laws denouncing penalties against the stoppage of, or interference with, the mails has never been doubted, yet they were enacted for the protection of the mails, and depend for their validity upon the power to protect being incidental to the power to establish. Says the Supreme Court of the United States, in 4 Wheaton, 417: "This power (to establish post-offices and post-roads) is executed by the single act of making the establishment. But from this has been inferred the power and duty of carrying the mail along the post-road from one post-office to another. And from this implied power has again been inferred the right to punish those who steal letters from the post-office or rob the mail. It may be said with some plausibility that the right to carry the mail and to punish those who rob it is not indispensably necessary to the establishment of a post-office and post-road. This right is indeed essential to the beneficial exercise of the power, but not indispensably necessary to its existence.

No one doubts or denies the right or power of the Government to punish the robber of the mails. Is it not just as legitimate, just as constitutional, to protect against the ravages of water as against the knavery of the robber?

The power of Congress to regulate commerce includes the regulation of intercourse and navigation. (18 Howard, 421.)

Commerce undoubtedly is traffic; but it is something more. It is intercourse. It describes the commercial intercourse between nations and parts of nations in all its branches, and is regulated by prescribing rules for carrying on that intercourse. (Story, Vol. 2, p. 4.)

This power to regulate commerce is a very general one, and a wide latitude of construction has been given it.

If a levee system tends, in any appreciable degree, to afford ease and safety to commerce, to intercourse which is essential to the carrying on of commerce, then appropriations of money by Congress to construct and maintain such a system finds abundant justification in this grant of power.

That it does afford ease and safety to commerce we have the declaration of the River Commission in repeated reports to Congress, as well as the statements of individual members of the commission before the committees of Congress. These say that the levees give safety and ease to navigation and promote and facilitate commerce and trade by establishing banks or landing places above the reach of floods, upon which produce may be placed while awaiting shipment, and where steamboats and other craft may land in time of high water.

If the Federal Government can legitimately expend millions in affording facilities to commerce by improving the *low-water* navigation of rivers, by parity of reasoning it may just as legitimately expend millions in improving the *high-water* navigation of rivers like the Mississippi, liable to overflow their banks.

By the navigation of rivers is meant not alone the passage of steamers and other craft up and down, but in a larger sense it includes likewise facilities for landing along the rivers for the loading and unloading of cargoes, the taking on and putting off of passengers, etc. In other words, it embraces the affording of all needful facilities for intercourse, trade, traffic, and commerce, besides the width, depth, and extent of water requisite for the safe passage of boats.

Again, navigation is only one of the elements of commerce. It is an element of commerce because it affords the means of transporting merchandise and the products of the country, the interchange of which is commerce itself. The river is but an instrument of commerce.

The power to regulate commerce is a power to regulate the instruments of commerce. (Gray *vs.* Clinton Bridge, 16 American Law Register, 152.)

It extends to the persons who conduct it as well as to the instruments used. (Cooley *vs.* Board of Wardens, 12 Howard, 316.)

The commerce of the river and the commerce across the river are both commerce among the States, and may be regulated by Congress, and should be regulated by that body when any regulation is necessary. (16 American Law Register, 154.)

It is now conceded that Congress, under the commercial clause, may regulate railroads. May it not also regulate the Mississippi, a national highway and an instrument which commerce makes use of, so as to prevent it disturbing the commerce and intercourse going on by rail and by highway in its valley?

The term "to regulate commerce" gives the power to restrain the destructive force of the thing used by commerce in its transactions. It is an incongruity to say that Congress, in the exercise of that power, may deepen or enlarge a river but cannot curb its force or exercise restraint over it.

The power "to regulate commerce" necessarily includes protection to commerce. This idea has been acted on from the commencement of the Government. The construction and maintenance all along our coasts of light-houses, beacon-lights, fog-signals, sea-walls and break-waters attest this. All are for the protection and convenience of commerce.

The laws of the United States require steam-vessels to pay for the license or privilege to navigate, and the officers manning such vessels are required to pay for the license or privilege of pursuing their respective calling or vocation, such as master, pilot, mate, etc. These vessels engage in the coasting trade as well as in the carrying trade, and Congress is as much under obligation to afford the needful facilities for the transaction of this coasting trade as it is for the transportation of through freights. One of the facilities needed along the Mississippi for the coasting trade is convenient landing places at all times.

In seasons of flood these landing places are supplied by levees, and, in this sense, levees are but continuing piers or quays.

This question of regulating the Mississippi river certainly comes within the general police power of the Government, under which power "persons and property are subjected to all kinds of restraint and burdens in order to secure the general comfort, health and prosperity of the State." (27 Vt., 149; 5 Otto, 471.)

In the latter case the Supreme Court, speaking of the deposit in Congress of the power to regulate commerce, says:

> "What that power is it is difficult to define with sharp precision. It is generally said to extend to making regulations promotive of domestic order, morals, health and safety. As was said in Thorp *vs.* The Rutland and Burlington Railroad Company (27 Vt., 149), it extends to the protection of the lives, limbs, health, comfort and quiet of all persons, and the protection of all property within the State. According to the maxim, *Sic utere tuo ut alienum non lædas*, which, being of universal application, it must of course be within the range of legislative action to define the mode and manner in which every one may so use his own as not to injure others."

If the Government fails to exercise its police powers to control its property, and this property, like a great river, rises and inundates the country, and great damage to individuals results, the Government is, or ought to be, responsible.

Take the case of an Indian tribe placed by the Government upon a reservation, and over which it exercises jurisdiction and surveillance. From some cause an outbreak occurs. The Indians throw off the restraint they are under, band themselves together, commence hostilities, and raid the surrounding country. For the damage and loss occasioned individuals by such an outbreak the Government has repeatedly acknowledged its liability, and Congress has over and over again appropriated money to make good such losses.

Is there not some ground for claiming that the Government should be equally responsible for losses occasioned by the Mississippi when it, in time of flood, raids the adjacent country?

The Government not only assumes paramount jurisdiction over the river, but asserts a proprietary interest in and to it.

Why, then, should it not be under obligation to restrain and control it equal to the restraint and control it admits it should exercise over an Indian tribe placed by it upon a reservation?

The first clause of Section 8, Art. I of the Constitution, prescribes that "Congress shall have power to lay and collect taxes, duties, imposts and excises, to pay the debts and provide for the common defence and general welfare of the United States."

I agree with the interpretation that the above clause was not intended to invest Congress with the independent and general power "to provide for the general welfare," and that the latter part of the clause, to wit, "to pay the debts and provide for the common defence and general welfare," is but a modification or qualification of the preceding part, viz: "Congress shall have power to lay and collect taxes, etc."

Nothing more was granted by that part ("to pay the debts and provide for the common defence and general welfare") than a power to appropriate the public money raised under the other part ("to lay taxes"), etc.

Said Thomas Jefferson:

> "To lay taxes to provide for the general welfare of the United States is to lay taxes for the purpose of providing for the general welfare; for the laying of taxes is the power and the general welfare the purpose for which the power is to be exercised. Congress are not to lay taxes *ad libitum* for any purpose they please, but only to pay debts or provide for the welfare of the Union."

Under this interpretation, while a general power to legislate for the "general welfare" is excluded, Congress is still authorized to provide money for the common defence and general welfare, and this is quite broad enough for the practical purpose we have in view. Indeed, the power to lay taxes is in express terms given to provide for the common defence and general welfare. And, as laid down by Story:

> "It is not pretended that when the tax is laid the specific objects for which it is laid are to be specified, or that it is to be solely applied to those objects."

It suffices that all taxes must generally be laid for one or all of three purposes, namely, to pay debts, to provide for the common defence, or the general welfare. And when funds have accumulated in the Treasury from taxes laid for any or all of these purposes, as said by President Monroe in his message of May 4, 1822:

"The power of appropriation of the moneys (by Congress) is co-extensive; that is, it may be appropriated to any purpose of the common defence and general welfare."

In other words, if operating under the latter clause, the taxes laid must be applied to some particular measure conducive to the general welfare. Or, as laid down by Mr. Story (Vol. 2, p. 162):

"The only limitation upon the power (to appropriate in aid of internal improvements) are those prescribed by the terms of the Constitution, that the objects shall be for the common defence, or the general welfare of the Union. The true test is whether the object be of a local character and local use, or whether it be of general benefit to the States. If it be purely local Congress cannot constitutionally appropriate money for the object. But if the benefit be general it matters not whether in point of locality it be one State or several, whether it be of large or small extent, its nature and character determine the right, and Congress may appropriate money in aid of it, for it is then in a just sense for the general welfare."

It is not only the right but the duty of Congress to advance the safety, happiness and prosperity of the people, and to provide for the general welfare by any and every act of legislation within constitutional limits, which it may deem to be conducive to those ends.

No one will have the temerity to question the proposition that the protection of the extensive alluvial valley of the Mississippi from destructive floods will be in the national sense of that term conducive to the general welfare.

Not one State, but a dozen; not a few thousand people, but millions are directly interested and affected for weal or woe according as the protection is extended or withheld.

If it were to the general welfare that we should acquire this territory, as we did, from France, it is equally conducive to the general welfare to preserve it as a habitable, cultivatable country, to protect it against relegation to its primeval condition of jungles and swamps.

Congress has exercised, not without question, it is true, but long enough for complete acquiescence, the power to lay taxes to protect and encourage domestic manufactures.

This has been and is being done on the ground that it is conducive to the general welfare to encourage domestic manufactures. But it is not one whit more conducive to the general welfare, if as much so, than protecting the finest portion of our common country for purposes of habitation and cultivation is.

All must admit that the powers of the Government are limited and that its limits are not to be transcended. But the sound construction of the Constitution must allow the National Legislature that discretion, with respect to the means by which the powers it confers are to be carried into execution, which will enable that body to perform the high duties assigned to it in the manner most beneficial to the people. (4 Wheaton, 421).

In McCulloch *vs.* Maryland (4 Wheat., 415) Chief Justice Marshall aptly referred to the Constitution as "intended to endure for ages to come, and consequently, to be adapted to the various crises of human affairs."

And in Hunter *vs.* Martin (1 Wheat., 304) it was said: "The instrument (Constitution) was not intended to provide merely for the exigencies of a few years, but was to endure through a long lapse of ages, the events of which were locked up in the inscrutable purposes of Providence. It could not be foreseen what new changes and modifications of power might be indispensable to effectuate the general objects of the charter. * * * Hence, its powers are expressed in general terms, leaving the Legislature, from time to time, to adopt its own means to effectuate legitimate objects, and to mould and model the exercise of its powers as its own wisdom and the public interests should require."

When the great Father of Waters, unhindered by an adequate levee system, rises out of its banks and sweeps with resistless might over the valley, a more than crisis, a sad realization of the worst, is upon the people of that unhappy section, and this grievous affliction of one of the members of the body-politic, in more or less degree, disastrously affects the whole.

That the capacity to provide for contingencies as they may happen exists in the Federal Constitution none will deny.

The trials it has undergone, the tests it has been put to and triumphantly emerged from, in the hundred and odd years of its existence, abundantly establish this.

J. A. Ockerson

THE MISSISSIPPI RIVER

NATURE'S GREATEST HIGHWAY

BY J. A. OCKERSON

THE Mississippi river is a commercial highway of immense value. It penetrates the heart of the most fertile section of the Union for a distance of about 2,500 miles; its navigable tributaries, aggregating over 15,000 miles in length, reach out in all directions toward the remote limits of this great valley. It drains a territory whose area equals in extent the combined area of Austria, Germany, Holland, France, Italy, Portugal, Spain, Norway and Great Britain. The river itself, in its winding course, covers a range of 6¼ degrees in longitude and 18½ degrees in latitude.

The headwaters of its tributaries extend in longitude from New York on the east to western Montana on the west; and reach in latitude from British America on the north to the Gulf of Mexico on the south; or about 1,800 miles in longitude and 1,500 miles in latitude.

This vast drainage area, 1,256,000 square miles in extent, is equal to nearly one-half of the total area of the United States. It touches 30 States, 2 Territories and 2 provinces of the British possessions. Only eight States to the eastward, and seven States to the westward, lie entirely beyond the confines of this great basin.

The rain which falls on this area is gathered in countless rivulets which grow in strength and volume as they unite with one another until finally they reach the dignity of a navigable stream, or a mighty river, all moving down to mingle their waters in the parent stream which carries the enormous burden through narrow confines to the Gulf of Mexico.

At flood time the discharge amounts to two million cubic feet per second. This enormous volume, gathered from regions far remote from the lower alluvial valley, would compass its destruction were it not guided and restrained by artificial embankments.

The floods not only bring down great volumes of water, but also carry vast quantities of sediment gathered from the Rocky Mountains in the remote Northwest to the Alleghanies in the East. The burden thus gathered is borne along on its journey to the sea, reinforced as it goes by immense quantities of material eroded from the river banks, all of which is carried along until the load becomes too great for the velocity, when a portion of it is dropped. This action, often repeated, results in sand bars which obstruct the free navigation of the river. These obstructions do not cover more than 10 per cent. of the river from St. Louis to the Gulf, the depth for the remaining 90 per cent. being ample to satisfy all demands of navigation. For a distance of 300 miles from the Gulf to the mouth of Red river, the depth of water is sufficient at all times to float the largest sea-going craft.

The regulation and control involve two distinct problems; one, the improvement of low-water navigation to such an extent that full cargoes may be carried to the sea at all times; and the other, the control of the floods so that the alluvial valley can be inhabited with safety and its unparalleled fertility can be made available by cultivation.

It has been shown that a very large portion of the country contributes to the evil conditions of sandbar and flood. It seems reasonable that it should also assume its share in the great work of guiding and controlling the waters so that they will flow harmless to the sea, bearing in safety the burdens of commerce. In like degree, the great benefits incident to good navigation and the opening to cultivation of extensive tracts of fertile soil will be beneficially felt in all parts of our country.

Coming now to the stream itself, it will be desirable to trace its characteristics from its source in northern Minnesota to the Gulf of Mexico, 2,250 miles southward. Various changes due to the influx of tributaries and other causes are met with as it moves towards the sea, and a clear comprehension of the physical characteristics of the stream make it desirable to consider the river in reaches.

First. From its source, near Lake Itasca, to Fort

THE MISSISSIPPI RIVER ABOUT A MILE BELOW THE ULTIMATE SOURCE AS IT FLOWS INTO NICOLLET MIDDLE LAKE.

Snelling, at the mouth of the Minnesota river, a distance of about 560 miles.

The source of the Mississippi river lies in a basin surrounding Lake Itasca. This basin has an area of about 25 square miles and is well defined by a range of pine-clad hills of considerable height and composed of glacial drift.

The river has its origin in a series of springs lying along the base of the hills in the southwestern part of the basin, and their waters coming together form a brook, which flows through middle and lower Nicollet lakes and enters the west arm of Lake Itasca near its southern extremity.

Lake Itasca is about 3¼ miles long, and it has a maximum depth of about 50 feet. The Mississippi river flows from the northern extremity of the lake with a width of about 30 feet, a depth of 5 feet, and a velocity of about 3½ feet per second.

The head of commercial navigation reaches to within 25 miles of the source of the river. This is the highest point reached at present by the lumber interests, and thousands of pine logs are floated down every summer.

The river flows north for a distance of about 60 miles and then turns eastward, passing through Bernidji, Cass and Winibigoshish lakes, after which the course is changed to a more southerly direction.

Near the upper part of the reach lie the great reservoirs, which have a storage capacity of 93,476,000,000 cubic feet of water. The drainage area is about 20,000 square miles in extent, 2½ per cent. of which is covered by the reservoirs.

The water in these reservoirs is allowed to escape during the low-water months, giving a marked increase in the depth of the stream as far down as Lake Pepin, a distance of nearly 500 miles below the upper reservoir.

From the source to Aitkin, Minn., a distance, by river, of about 345 miles, the stream for the most part flows between low, marshy banks. The oscillations in stage are small, and the free flow is interrupted by reservoir dams and occasional rapids. It is generally locked in ice and snow from November to April.

Between Aitkin and the mouth of the Minnesota river, a distance of about 205 miles by river, there are several obstructions in the shape of water-power dams and the falls of St. Anthony. Owing to these obstructions there is very little steamboat traffic in this portion of the river. The traffic in lumber and logs, however, amounts to 700,000,000 feet during each short summer season.

No accurate determination has been made of the elevation of the extreme head of the river above sea

THE NISSISSIPPI RIVER AS IT ENTERS THE WEST ARM OF LAKE ITASCA.

THE MISSISSIPPI RIVER AS IT LEAVES NORTHERN EXTREMITY OF ITASCA LAKE.

level, but it has been roughly determined as *1,560 feet. At the mouth of the Minnesota River the elevation is 690 feet. The fall in the first reach is 56 per cent. of the total fall of the entire river and averages about 1.5 feet per mile.

The extreme oscillation of stage at the lower end of the reach is 19.5 feet. The discharge varies from 1,000 cubic feet per second at low water, to 117,400 cubic feet per second at high water.

The tributary streams in this reach are numerous but small, the principal ones being the Swan, Pine, Crow Wing, Elk and Rum rivers.

Second. From mouth of Minnesota River to the mouth of the Missouri River a distance of 705 miles.

The chief tributaries coming into this reach of river are the Minnesota, St. Croix, Chippewa, Wisconsin, Iowa, Des Moines and the Illinois.

In the upper portion of this reach the river is divided into numerous sloughs which serve as channels in high water, many of which are dry at low water.

The banks are generally low and the oscillation between high and low water at the lower end of the reach has a maximum range of 26.5 feet.

The discharge ranges from about 2,000 cubic feet per second at extreme low water to 350,000 cubic feet per second at high water.

The elevation of the low water at the lower end of the reach, above sea level, is 403 feet and the slope of the entire reach averages 0.5 feet per mile.

The water carries but little sediment and it is often desirable to pump the material from the bottom and deliver the same against the contraction dikes in order to make them quickly effective.

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*See map of Hon. J. V. Brower, Commissioner Itasca State Park.

SOME OBSTRUCTIONS IN THE MISSISSIPPI RIVER NEAR ITS SOURCE.

Comparatively little bank erosion occurs in this reach. For a stretch of 21 miles the water flows through Lake Pepin, a body of slack water 30 feet deep; at Rock Island and at Keokuk the flow is interrupted by rapids where the bed of the stream is solid rock. Before any improvement work was done the navigable depth at low water often went down to 2½ feet; where the improvement work has reached near the stage of completion, the depth rarely goes below 4 feet. Navigation is suspended during the winter season for a period of four months or more when the river is frozen. High water generally comes in May and June and the low water begins about the first of September and continues until the river thaws out in the spring.

The general improvement of this portion of the river is effected by means of contraction works and closure of chutes, aided by dredging.

At Rock Island Rapids the improvement consists of the removal of rock and concentration of volume by dikes and dams. The rapids at Keokuk are surmounted by means of a canal with eight miles of slack water navigation and with three locks having a total lift of 18 feet.

Third. The third reach extends from the mouth of the Missouri to the mouth of the Ohio, a distance of about 210 miles. Here the water becomes heavily charged with sediment, and permeable dikes which are used in the improvement works readily induce immense deposits. The banks in this reach are somewhat higher than those above, and the effects of bank erosion are more decided.

The extreme range between high and low water at St. Louis is 37 feet, with the single exception of the flood of 1844, which reached 41 feet. The low-water slope averages about 0.6 feet per mile and the discharge ranges from about 45,000 cubic feet per second at low water to 850,000 cubic feet per second at high water. Overflows are not frequent and only occur when the floods of the Upper Mississippi and Missouri rivers are coincident. The high-water stages usually occur in May and June and the low-water season, beginning in September, often extends into the winter months. Sandbars are numerous, and the navigable depth at times is as low as 4 feet at the shoalest points. The river washes the rocky bluffs on one bank or the other a greater part of the reach, and at Gray's Point, 1,100 miles above the mouth, it flows through a rocky gorge for a distance of about 7 miles. Below this gorge the normal conditions of the stream are often affected by backwater from the Ohio, which causes a deposit of the sediment that becomes a prolific source of annoyance to navigation and causes active bank erosion. This reach is sometimes frozen over for a month or more during the winter, but more often it is open for navigation throughout the year. The whole reach shows many of the characteristics of the Missouri.

The principal tributaries coming into the main stream in this reach are the Missouri, Merrimac, Okaw and Big Muddy rivers.

The system of improvement adopted consists of contraction of the low-water channel by means of hurdles or permeable dikes, the closure of chutes, the revetment of banks and the use of hydraulic dredges. These works, where completed, have shown very good results in the way of increased depth and justifies the belief that a navigable depth of at least seven feet at extreme low water is entirely practicable.

Fourth. The fourth reach extends from the mouth of the Ohio to the mouth of the Red river, a distance of about 750 miles. At the head of this reach comes in the Ohio, reinforced by the Tennessee, Cumberland and other tributaries, which combine to control the flood conditions of the lower Mississippi river. The principal tributaries of the fourth reach are the St. Francis, White, Arkansas and Yazoo, which at times add very largely to the flood volume carried by the main stream.

The Missouri river conditions noted in the third reach are no longer the controlling factors except as regards sediment; the great floods which are so destructive come from the Ohio basin. The bed of the stream is through deposits which it has built up and torn down repeatedly.

At a few points the lateral movement of the river is held in check by the bluffs, but it lies largely along the eastern portion of the alluvial plain. It washes the bluffs at 15 points on the east side and at only one point on the west side. The caving in the middle third of this portion of the river reaches enormous proportions. A large percentage of the alluvial banks throughout the reach yield readily to the eroding power of the current, and this erosion amounts to an average area of about nine acres per annum for each mile of river. In places the river becomes excessively wide by encroaching on first one bank and then on the other, as in the vicinity of Point Pleasant, Mo.; again it becomes exceedingly crooked by the continued erosion of the concave bank. The most marked case of this kind lies between Arkansas City and Greenville, where the air-line distance is about 15 miles while the river distance is 40 miles.

The width of the river reaches a maximum in the fourth reach, the high-water banks being sometimes two miles apart. The banks are 30 to 45 feet in height above low water. Overflows are frequent, except where floods are restrained by levees. The sandbars are very large in extent and wooded islands and towheads are numerous.

There are about 40 bars or crossings in this reach which may become obstructions to navigation, the depths on a few of them, at times, reaching as low as 5 feet; but 95 per cent. of the length of the reach has ample depth of water to satisfy all of the demands of commerce, many of the bends being over 100 feet deep. It rarely, if ever, happens that all of the bars above named show shallow depths at the same time or even during the same season.

Floating ice, at intervals of three or four years, enters this portion of the river, but rarely causes the suspension of navigation.

The low-water season covers a period of about four months in the fall of the year, during which time navigation may be interrupted by shallow water, but now and then entire years pass without any such interruptions. The floods usually come in the winter or early spring months. The extreme range in stage from low to high water is about 53 feet and the discharge ranges from 65,000 cubic feet per second at low water to 2,000,000 cubic feet per second at high water.

The destructive floods enter the alluvial basin at the upper end of this reach and sweep its entire length, gathering strength as they go and often remain at an overflow stage for a period of nearly three months.

To control these floods levees are being constructed on the right bank from Point Pleasant, Mo., to Walnut Bend; from Helena to near mouth of White river and from above Arkansas City to Bougere, 30 miles above mouth of Red river, a total length of levee on right bank of about 490 miles. On the left bank the levee begins at the head of Horn lake below Memphis and extends to Eagle lake above Vicksburg, a total length of 318 miles.

The small areas lying between the bluffs and the river have not yet been leveed, owing to the difficulties of drainage and the cost which would generally far exceed the value of the land protected.

The elevation of the upper end of the reach at low water is about 270 feet, and at the lower end the elevation is about 2 feet above sea level. The low-water slope averages 0.35 feet per mile.

At the head of this reach is where the problem of regulation and control divides into two distinct parts, viz, improvement of low-water navigation and control of the flood waters to prevent the overflow and consequent destruction of nearly 30,000 square miles of rich alluvial land.

The control of the floods can only be accomplished by means of a system of substantial levees such as are now in progress.

The demands of commerce require a navigable depth of not less than 8 feet at low water, and this depth or more can be obtained by means of suitable contraction works where the low water stream is too wide, by the closure of chutes, the revetment of banks and the judicious use of powerful hydraulic dredges.

Thus far the work of maintaining navigable channels by means of hydraulic dredging has been largely confined to this reach, although some work has been done in this line in the second and third reaches.

Fifth This reach extends from the mouth of the Red river to the Gulf of Mexico, a distance of 310 miles.

In this portion of the river the channel is narrow, averaging about a half mile in width and the depth sometimes exceeds 200 feet. Bank erosion is slight as compared with the fourth reach, sand bars as obstructions to navigation are almost unknown and neither contraction works or dredging are required. Here nature has constructed an ideal channel with depths sufficient at all times for the largest sea-going craft. For nearly the entire length the water is confined to a single channel down to the Head of the Passes, there being but two islands, Profit and Bayou Goula, in the entire reach.

As the upper limit of the reach at low water is less than 2 feet above mean Gulf level, it often happens that the tidal effect is noticeable throughout its entire length.

The Red river is the only tributary in the fifth reach which adds to the volume of the main stream.

There are several outlets through which the waters of the river can flow to the Gulf of Mexico. Some have been closed by levees, as Manchac and Plaquemine Bayous. The Atchafalaya, La Fourche, Collet, The Jump and Cubitts are still open but are gradually filling up with deposits of sediment.

At the head of this reach is the Atchafalaya, which is the first practicable outlet to the sea for waters coming down from the great drainage basin of the Mississippi. Any water escaping over the banks of the stream above this point must return again to the main stream to swell the volume already in the channel.

The levees are here built on the immediate banks of the stream, and the burdens of a flood gathered from a basin 1,800 miles wide must here pass between the natural banks and the artificial embankments raised on them, which are only about half a mile apart. The levees on the right bank extend from the Atchafalaya to The Jump below Fort Jackson, a distance of 287.2 miles. On the left bank the levee begins at Baton Rouge and extends down to near Fort St. Phillip, a distance of 207.0 miles.

The extreme oscillation in stage recorded up to the present time at New Orleans is 20.7 feet.

At the Head of the Passes the river divides into three main branches, viz, Southwest pass, South pass and Pass à Loutre. South Pass has been improved by means of jetties, and is now the only navigable channel from the river to the sea for vessels trading at the port of New Orleans. It has a navigable depth of 26 feet while the other passes have only 11 feet across the bar at the Gulf.

Owing to the extraordinary increase in size and draft of ships, South pass is now altogether too small to satisfy the demands of commerce. These conditions will soon require the improvement of Southwest pass, which has double the width and five times the capacity of South pass. A depth of 35 feet can doubtless be obtained in this pass, and this depth will accommodate any vessels which can enter the principal Atlantic or foreign ports as they now exist.

The above outline of the physical characteristics of the stream will give some idea of the magnitude and importance of the problem of the regulation and control of the Mississippi river

IMPROVEMENT OF NAVIGATION.

The most important phase of the problem of regulation is the improvement of navigation.

In point of economy, the advantages of water routes over all other methods of transportation are so apparent as to leave no room for discussion. It is not too much to say that the cost of transportation on the Mississippi river is much lower than the freight charges necessary to meet the legitimate interest on the actual cost of construction and equipment of the best trunk line railroad in the country, to say nothing of the maintenance of way and operating expenses.

The importance of preserving a navigable channel in the Mississippi river to meet all the demands of commerce is, therefore, apparent.

The permanent improvement of a stream of such gigantic proportions will necessarily require large expenditures of money and a long period of time. In the meantime, temporary expedients must be resorted to for the purpose of maintaining a channel of the required depth. For this purpose powerful hydraulic dredges and portable jetties are made use of.

As has already been stated, the obstructions to navigation are confined to a few sand bars which cause shallow depths during a period of about three months of each year. These obstructions are generally found between two pools and form the crossing over which steamboats must travel, as they cross from a pool lying in a bend along one bank to the pool in the bend along the opposite bank.

The first effect of a flood, with its increasing velocity, is to erode the bed and banks of the river and add this material to the load already carried in suspension. This action continues until the crest of the flood is reached and the decline sets in. The load is now too heavy for the diminishing velocity, and the burden is rapidly deposited on the crossings, and obstructions are formed which, later, may become serious hindrances to navigation.

When the river reaches a low stage, these bars act as dams to hold the water in the pools. The slope on the crossing is thereby increased and likewise the velocity. The crest of the bar consequently cuts out, and if this scour is confined to one channel, it generally results in a good navigable depth. If the bar is wide and flat, there will probably be several incipient channels, none of which will answer the requirements of navigation. These must be concentrated by contraction, or dredging, or both.

Figure 1 shows rather a complicated bar condition near Point Pleasant, Mo., 80 miles below mouth of the Ohio. The general course of the river in this section is straight for several miles. The width is unusually great, due to the erosion of both banks, and the channel is consequently shallow and shifting.

In the diagram the pools are shown by parallel shading, and the figures indicate the depth at low water. The upper pool comes down the right bank and terminates at A, and the problem then is to reach the pool B over the reef or sand bar separating the two pools. After crossing the bar, navigation to the lower end of the pool at C is easy. Then comes another crossing to D, followed by a narrow broken pool to I; another crossing and the fourth pool is reached at J. The depth is then ample to M, and after crossing another reef to N, this stretch of bad navigation is passed.

Another route might have been opened from L to K and G to H.

Figure 2 shows a simple crossing, such as is most frequently met with. The problem is simply to cross one reef lying between the upper and lower pools, this short bar being the only obstruction to navigation for several miles above and below.

The problem then resolves itself into opening channels through the reefs, composed chiefly of loose sand lying between successive pools.

So far the problem seems simple enough, but there are other difficulties known only to the engineer taught by long observation and experience or those who have observed the river through many years of changes. While the artificial cutting is going on, nature may be doing some cutting on her own account, but on such a gigantic scale that the work of the largest dredges becomes insignificant in comparison with it. By the time the engineer gets what he considers a dredge of enormous capacity into position to open a channel through a bar, the natural forces may be diverted toward another route, or may throw enormous deposits over the bar and obliterate the dredged channel as fast as it can be opened.

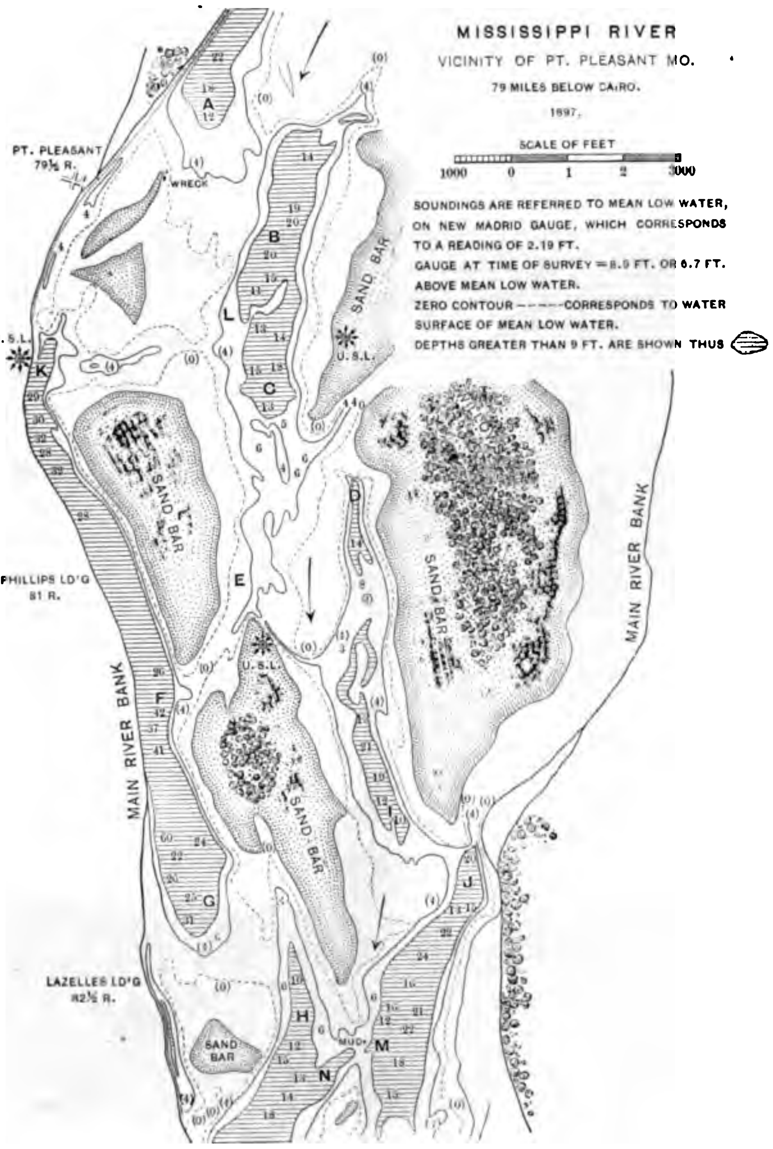
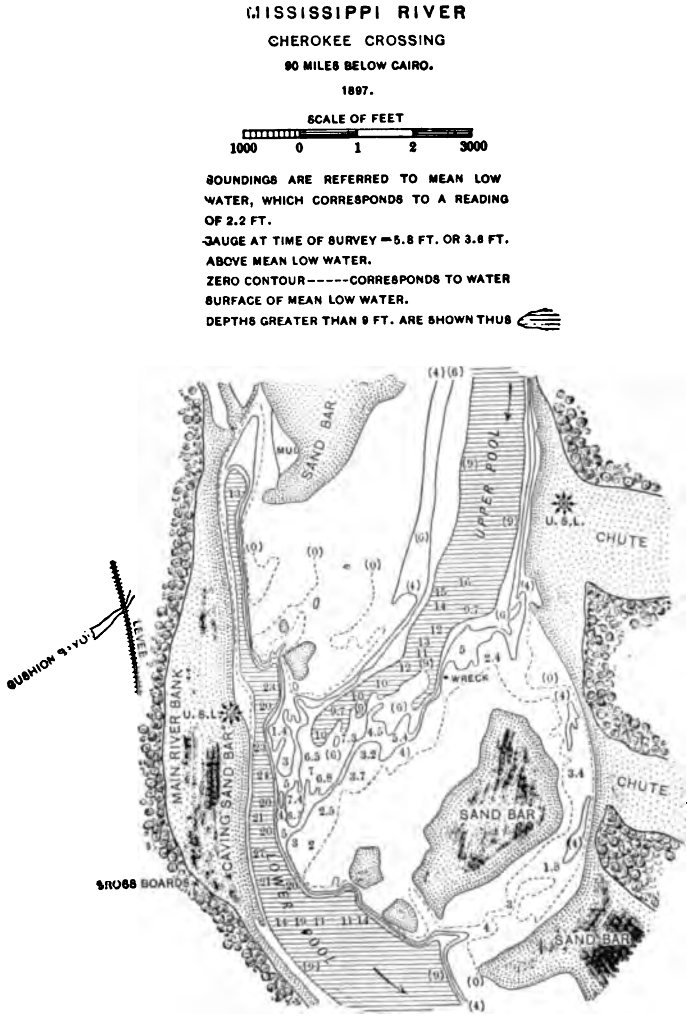

MISSISSIPPI RIVER
VICINITY OF PT. PLEASANT MO.
79 MILES BELOW CAIRO.
1897.
SCALE OF FEET
1000 0 1 2 3000
SOUNDINGS ARE REFERRED TO MEAN LOW WATER, ON NEW MADRID GAUGE, WHICH CORRESPONDS TO A READING OF 2.19 FT.
GAUGE AT TIME OF SURVEY = 8.9 FT. OR 6.7 FT. ABOVE MEAN LOW WATER.
ZERO CONTOUR ------ CORRESPONDS TO WATER SURFACE OF MEAN LOW WATER.
DEPTHS GREATER THAN 9 FT. ARE SHOWN THUS
PT. PLEASANT 79½ R.
WRECK
U.S.L.
PHILLIPS LD'G 81 R.
LAZELLES LD'G 82½ R.
MAIN RIVER BANK
SAND BAR
A
B
C
D
E
F
G
H
I
J
K
L
M
N
MUD

FIGURE 1.

The enormous volume of material moved along the bottom by the current, complicated by subtle changes of direction and force of flow which are difficult to account for, sometimes defeat the best efforts of the engineer.

It has been practically demonstrated, however, that in spite of all of these difficulties, a channel of ample depth can be maintained by means of suitable hydraulic dredges.

The Mississippi River Commission in 1891 began investigations to ascertain the best means of securing temporary relief for navigation pending the construction of works looking to the permanent improvement of the river.


MISSISSIPPI RIVER
CHEROKEE CROSSING
90 MILES BELOW CAIRO.
1897.

SCALE OF FEET
1000 0 1 2 3000

SOUNDINGS ARE REFERRED TO MEAN LOW WATER, WHICH CORRESPONDS TO A READING OF 2.2 FT.
GAUGE AT TIME OF SURVEY =5.8 FT. OR 3.6 FT. ABOVE MEAN LOW WATER.
ZERO CONTOUR-----CORRESPONDS TO WATER SURFACE OF MEAN LOW WATER.
DEPTHS GREATER THAN 9 FT. ARE SHOWN THUS

FIGURE 2.

After a thorough study of the subject, it was decided that among the many devices designed for cutting out sand bars, dredging was the only device which held out a reasonable promise of success. The construction of an experimental dredge was begun in 1893.

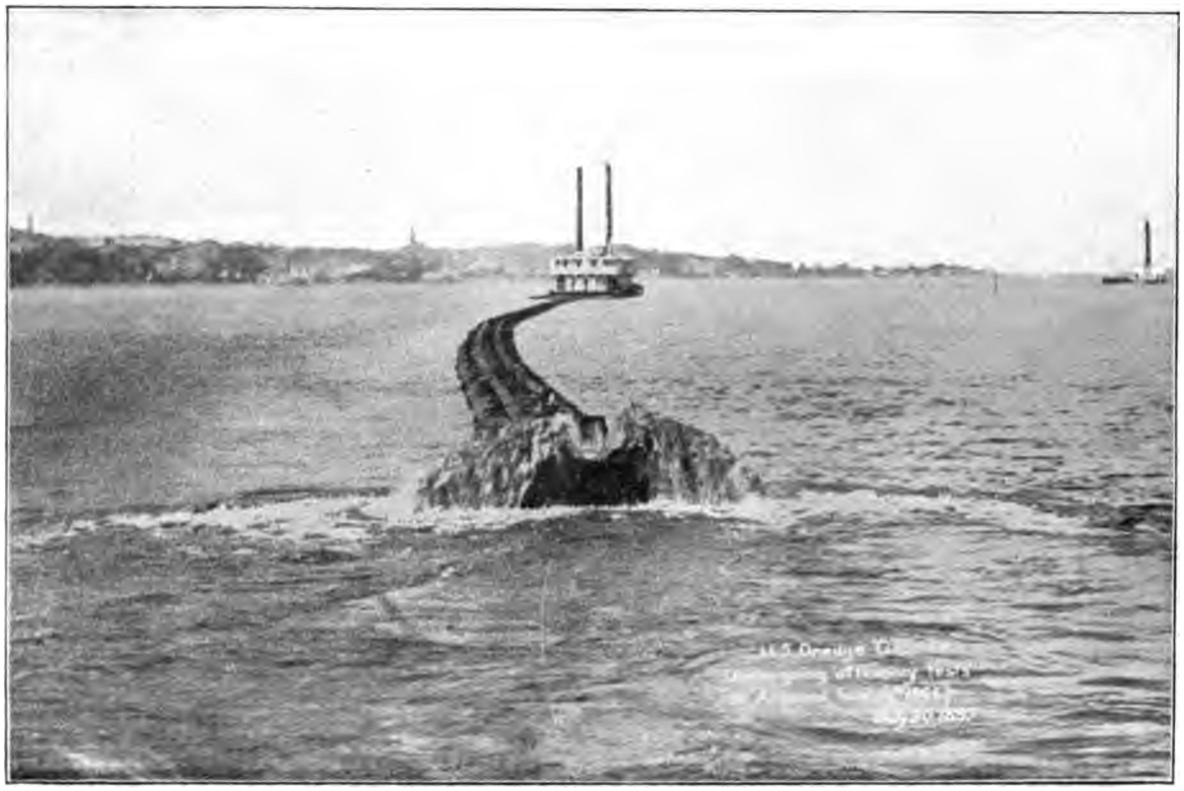
This dredge was called the Alpha. It has a wooden hull 130 feet long, 36 feet wide and 8 feet deep. In working order its draft is about 4 feet. The machinery consisted of an Edwards centrifugal pump having a curved drag suction at one end, and an Allis-Reynolds screw pump having a straight suction and jet agitators at the other end, the object being to make practical tests of the efficiency of the different devices.

The Edwards pump runner was 6 feet 4 inches in diameter, and was operated by a compound, non-condensing, vertical engine, with cylinders 15 and 27 inches in diameter, respectively, and with 20-inch stroke. The suction and discharge pipes were each 30 inches in diameter. The jet pump had a suction and discharge 15 inches in diameter, which supplied six 2½-inch jets under a pressure of about 20 pounds; the object of these jets being to loosen up the sand so that it will flow into the pump.

The Allis-Reynolds pump was driven by a compound, non-condensing, vertical engine, with cylinders 8 and 16 inches in diameter, and 12-inch stroke. This pump also had 30-inch suction and discharge pipes.

The steam is supplied by boilers of the ordinary Mississippi river type. Hoisting and hauling winches are provided for raising and lowering the suction and moving the dredge while at work.

The material pumped is discharged through a line of floating pipe made up in lengths of 33 feet and coupled together with flexible rubber joints and iron coupling bars. The necessary buoyancy is obtained by an air chamber on each side of the discharge pipe. The pipe can be deflected so as to deposit the material on the sides of the channel or in deep water below the bar. The length of discharge pipe is usually 1,000 feet.



A STEAM DREDGE AT WORK.

The dredge is moved back and forth along the required cut by means of two wire cables leading from the drums of the hauling winches to iron hydraulic piles set firmly in the sand at the upper side of the bar.

In dredging, the suction is lowered to the required depth and the dredge is hauled ahead at a rate varying with depth of material excavated, the speed ranging from 60 to 150 feet per hour.

When one cut is finished the cables are slackened and the dredge drops back to the lower side of the bar, the head piles are moved over about the width of the cut and another cut is made alongside of the first. This process is continued until sufficient width and depth have been secured.

The capacity of the Edwards pump with a suction-head 8 feet wide, is about 500 cubic yards of sand per hour.

The experiments with this dredge were so satisfactory that the construction of a dredge of much larger capacity was decided on. This dredge was completed in 1896. It is equipped with two complete pumping plants each operated by an engine of 1,250 horse power. The barge tests of this dredge showed an average capacity of 4,920 cubic yards per hour. In its present shape, the suction makes a cut 40 feet wide and 4 feet deep at a rate of about 150 feet per hour.

The dredging fleet at the present time consists of 6 dredges, the towboats and other plant necessary to operate them.

Three side-wheel self-propelling dredges are under construction and will be available for the next low-water season.

The later type of dredges have a capacity of about 1.200 cubic yards of sand per hour. The suction-head is about 20 feet wide and the suction and discharge pipes are 32 inches in diameter. The same general method of operating is employed in all of them.

The general type of the dredges now under construction may be briefly described as follows:

The hulls are of steel 192 feet long, 44 feet molded width, 70 feet wide over guards and 7 feet depth of hold. They have cabins 137 feet long and 34 feet wide, for the accommodation of officers and crew. They are fully equipped with cold-storage and electric-light plants.

The propelling machinery is of the ordinary Mississippi river side-wheel type built for working under a pressure of 170 pounds per square inch.

The cylinders are 22 inches in diameter and 7 feet stroke.

The main dredging pump is a centrifugal double suction pump with the discharge at the bottom and is placed along center line of boat. The water and sand enters the pump from both sides of the casing and is discharged through a pipe 32 inches in diameter. The engines operating the main pump are horizontal, tandem, compound, condensing type with high-pressure cylinders 16 inches in diameter and low-pressure 26 inches in diameter, with 20 inches stroke. These are designed for a speed of 160 revolutions per minute.

The jet pump which supplies the jets that stir up the sand is a horizontal, duplex, compound, plunger pump. The steam cylinders are 10 and 20 inches in diameter and 15-inch stroke. This pump is arranged to work at a pressure of about 60 pounds per square inch.

The hoisting and hauling winches are similar to those already described and the methods of operating are also essentially the same.

The dredge is provided with a vertical spud 22 inches square placed near the bow, by means of which the boat can be anchored at any desired point on the bar. The spud is easily operated by means of a steam cylinder 18 inches in diameter and 6 feet stroke.

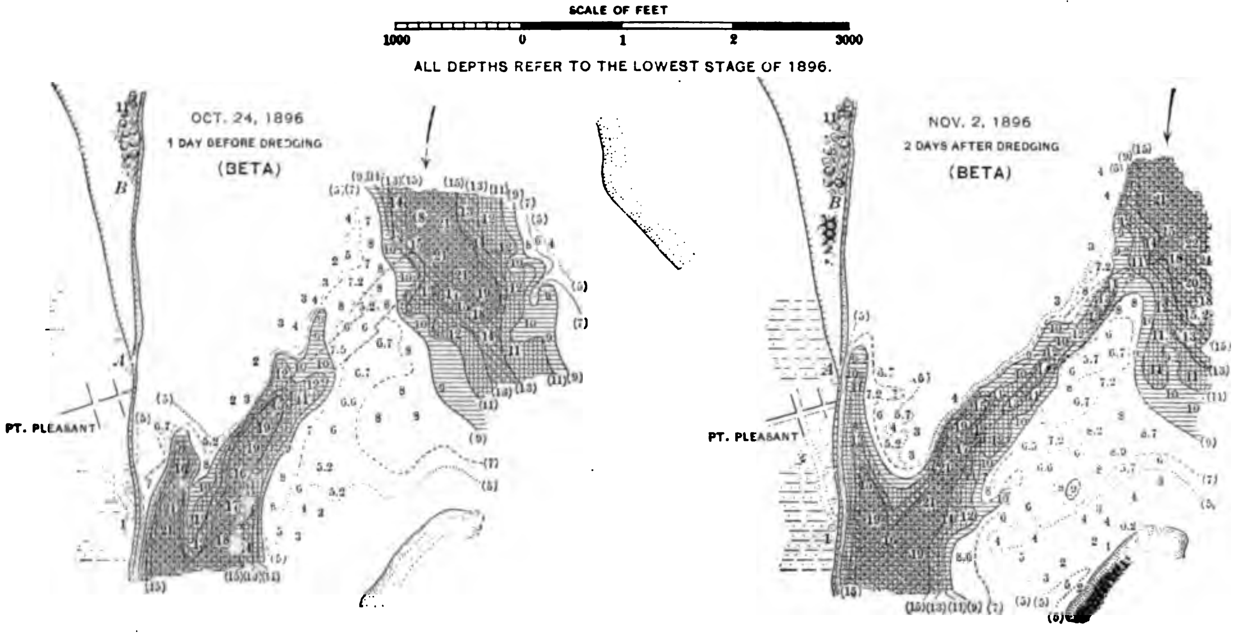
The suction-heads are made in two parts each 11½ feet wide and 8½ inches deep at the narrowest part.

These dredges are provided with machine shop and tools, sufficient to make all ordinary repairs on the spot and also with ample equipment of every kind that may be required to facilitate the work.

In the line of temporary relief, pending the permanent regularization of the stream, the work done for the benefit of navigation thus far has fully demonstrated the practicability of economically moving immense quantities of material in a short space of time with hydraulic dredges. It has also demonstrated that good navigable channels can be opened and maintained through the obstructing sand bars at a reasonable cost.

LOWER POINT PLEASANT BAR

79.5 MILES BELOW CAIRO



ALL DEPTHS REFER TO THE LOWEST STAGE OF 1896.

An adequate plant properly managed should readily eliminate all serious hindrances to navigation during the low-water season.

While there is yet much to be learned as to the proper location of cuts and conditions of flow and scour, it can be said, that so far, the failures have been few, while success has been the general rule.

A good illustration of the effect of dredging is shown in the accompanying diagram. The pools of deep water are shaded and figures show depth at low water. In the left diagram, showing conditions before dredging, it will be noticed that the depth on the reef is only 5 feet. Two days after dredging, the dredged cut shows the depths to be from 10 to 13 feet. Many similar cases could be cited which show equally decided results.

The good work done has already developed increased activity in the ship-yards and in the construction of new craft which are taking the place of the obsolete types of boats, which are neither economical or efficient for the service now required. Boats with steel hulls, modern machinery and boilers are making their appearance and in the near future we will doubtless see well equipped fleets of steel barges carrying grain from St. Louis to the seaboard to the mutual advantage of both shipper and carrier.

With a full complement of dredges ready for service, it will be entirely practicable to maintain a good steamboat channel with a least depth at lowest stages of eight feet or more.

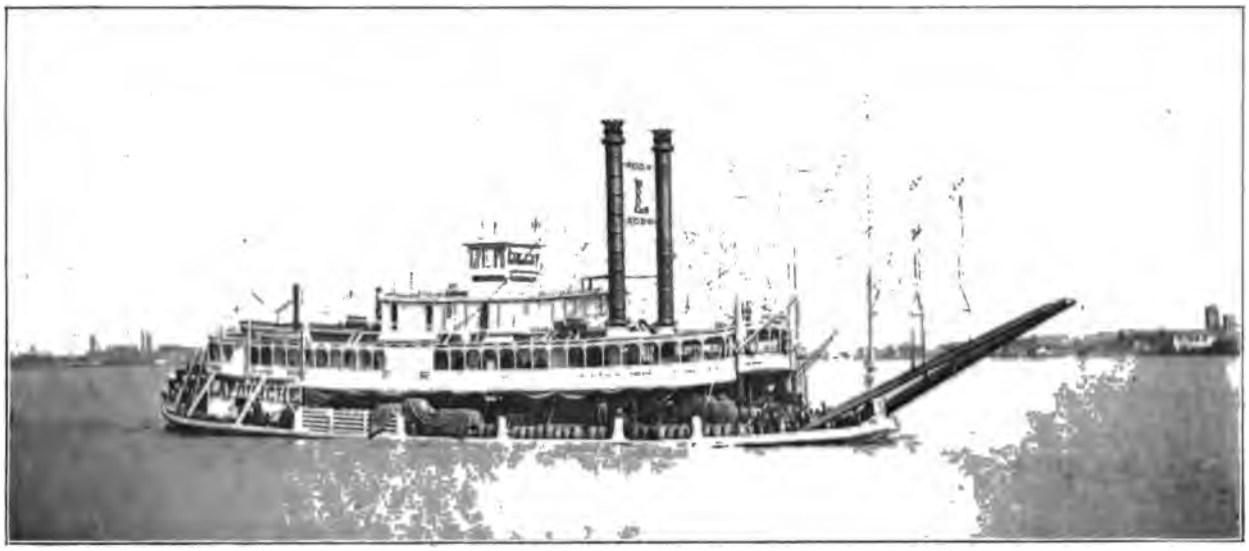
The stage from Cairo to the Gulf for two-thirds of each year gives a navigable depth of over twelve feet.

As this channel is very rarely blocked by ice like the Northern water routes via the Great Lakes, its immense value to the producers of the vast territory naturally tributary to it must be apparent and the interests of these producers and of the entire country demands that this channel be maintained in the highest degree of efficiency.

Although the importance of this highway even now can hardly be overestimated, still the opening of an isthmian canal will add very much to its value, as the traffic by water can be extended from the heart of the continent to the ports of the Pacific ocean.

Thus new fields for our exports will be reached, new industries will be developed and the traffic on the river will be greatly increased.

A CARGO OF GRAIN BOUND FOR NEW ORLEANS.



LOWER RIVER PACKET LOADED WITH SUGAR.

PORT EADS AT THE MOUTH OF THE MISSISSIPPI RIVER.

A. H. Leappée

THE LOWER MISSISSIPPI AND ITS REGULATION

BY H. ST. L. COPPÉE

TO one who for the first time sees the lower Mississippi river at the spring flood, leaving its alluvial bed and expanding its mighty power on the adjacent banks and submerged lands, sweeping through cultivated fields and forests and destroying everything in its path, the idea of control seems futile and absurd. In the mind, at once the question rises, How can this great sea of swiftly-flowing turbid water, boiling and eddying in great mælstroms of currents, ever be regulated? How can such potential energy ever be so conserved as to expend itself in kinetic force against the reacting creations of man's genius and be passed harmless and pacified to the ocean?

To those living before this era of progressive thought and inventive effort in every branch of applied science and art, the very dream of a possibility of controlling this mighty river, to the smallest degree, must have seemed worthy the brain of a poet, but surely not that of an engineer who knew the value in foot-tons of this fluvial giant and the opposing forces necessary to chain it to man's will.

Yet, under the domination of mind and will, in this golden time of applied science, slowly but surely the great problem is being solved, each year marking some further progress and greater benefits conferred by the untiring fight against this common enemy.

In pace with every upward step engineering science climbs, oftentimes leading the way. Hydraulic engineering is but one branch of general engineering practice; and to its practitioners has devolved the task of accomplishing what seemed at one time the impossible.

As far back as we can trace in the dim geological past we find the Mississippi river a vast waterway, sea or estuary or flowing stream, the great central artery of the North American continent, at all periods a channel of some sort. During the Champlain epoch great masses of melting ice furrowed their way through its channels that now lie buried many hundred feet under the more recent strata of marine and fluvial deposits. Later strange fauna swam in its turbid waters, and curious trees shaded its ever changing banks; these have been swept away in the long ages of pre-historic time, and replaced by the familiar organisms of the present.

From earliest time this great river has been a problem to mankind. The Indians viewed it with awe and superstitious wonder. It puzzled and ultimately checked the uncompromising spirit of the bold De Soto and his hardy followers, and his body was interred in the depths of its shifting bed.

To the early Canadian explorers seeking more extended dominions for the French throne, it seemed to join the very antipodes, as down its swiftly flowing waters they descended; hoping for an Eldorado that did not exist; past the muddy river from the arid plains in the West, on through the limestone causeway of the Ozarks, on through endless days and nights of journeying; by banks with noble trees—oak, cypress, ash and gum—festooned with vines in mighty chains, and pendants of fleecy moss, or bars of gravel, sand and mud, fringed with fragrant willows; on to their destination in the fever-breeding marshes near the sea; doomed to disappointment, but being the precursors of a civilization and commercial activity then undreamed of, even in the centers of culture and wealth of the Old World.

In spite of the invasion of civilization, much of the lower Mississippi river remains in the same primeval grandeur as it did in the time of La Salle. The same April sun shines on its eddying surface and forest-fringed banks, and the same April air wafts the sweet scent of the grape and jessamine over its broad bosom, flecked by drifting tree and vine, borne by the spring flood to a haven in some shallow inlet in the Gulf.

The Mississippi is always excentric in its flow, not behaving like other well-conditioned rivers, but objecting to the supposed laws of hydraulics it defies science and human ingenuity and reluctantly comes under the influence of well applied engineering practice, based on years of experience and hard fought battles with its uncompromising opponent.

Some one has said "The Lord has not finished making the Mississippi valley and it is not His intention that it should be inhabited or its river controlled." But be it in a geologic or post-geologic period, in a state of psychozoic transition or not, man and mind have sought its domain and propose to train it to their will. Occupying the very heart of the country and receiving its waters, tributaries and rainsheds, from the topmost ridge of the Alleghanies on the East, and the Rocky mountains on the West, its importance, from an industrial, commercial, and strategic standpoint, is immense. This was a well-recognized fact in colonial times, and in the beginning of our national history, and continues to be as our commercial and moral importance impress themselves more powerfully on the markets of the world.

Not many years ago though prosperous cities and productive plantations existed on the lower Mississippi, and intermittent navigation was carried on as a means of supply and export, practically nothing had been done to develop the vast agricultural domain reaching back many miles from its banks, by protecting it from annual inundation from high water and providing a means of uninterrupted transportation at low.

What has since been done to chain this powerful stream that unshackled, like China's great Yellow river, has been a sorrow and a terror to the riparian owner and navigator; but enslaved and properly guided to the sea, will prove an untold blessing to the inhabitants of this rich territory. The earlier attempts at control and regulation were but tentative and local, consisting in the construction of small levees for use also as roadways, in detached sections, protecting private property, in no way forming a continuous system. The first of these was built at New Orleans in 1717. It was about 4 feet high, had a crown of 18 feet and slopes 2 to 1 back and front.

These disconnected levees, having their origin nearly 200 years ago, have grown through a well-defined law of necessity, from the requirements of self-protection in the beginning, through the more extensively organized efforts of the local communities, levee boards, construction companies, etc., into the great State and National systems that exist to-day and will form a permanent barrier to future floods, when completed by the General Government to the dimensions dictated by scientific research. While the levee system was passing through the many stages of evolution, from the small New Orleans section to the finished dike of to-day, the importance of the river as a means of transportation for the products of the protected lands became more and more apparent. After many years of controversy as to the best means of improvement, and the writing of thousands of pages on canalization, regulation, etc., followed by active work of construction, a deep channel at the mouth of the river was opened to the sea. Jetties accompanied by dredging in South pass was the method proposed and carried out by Mr. Jas. B. Eads, then one of the most eminent engineers in America. This work was practically completed in 1879. Up to that time but little had been done on the Mississippi.

Local levee boards in Mississippi, Louisiana and Arkansas were making what progress they could with insufficient means and inadequate mechanical appliances for construction; the great majority of the levees being erected by shovels and barrows and small drag-scrapers. The prices paid for work were very high, consequently the results were very meagre. Specific appropriations had been made by the General Government for the protection of the banks at New Orleans, Vicksburg and Memphis, and work to a great extent experimental had been carried on, consisting in the revetting of the caving banks by means of small detached mattresses, dykes, screens, etc. To quote from the author's article in the *Engineering Magazine* of June, 1896:

"The early revetment work, which was purely for the protection of property in harbors and not for the general improvement of navigation (as, for instance, at New Orleans from 1878–1881), consisted of piles driven in pairs 6 feet apart along the bank, to which were fastened, by big iron rings, light mattresses 2 inches thick by 25 feet long and 24 feet wide, made of fish-pole cane sewed together by weaving double wires and afterward yarn under them. These small mats were first fastened together, forming sections 200 by 24 feet, and then sunk with iron weights. These mats were of little permanent value. They cost from $12.87 to $7.22 per square (100 sq. ft.).

"Another early revetment instanced by the work at Delta Point, opposite Vicksburg, consisted of mattresses built of willow brush and laid in cross-layers with top and bottom grillage of poles fastened together with hardwood pins and No. 10 wire. These mats were constructed on floating ways (a barge with inclined skids), and were 50 feet wide, 150 feet long and 2 feet thick. When finished they were launched into the river and sunk with the long axis normal to the bank by throwing stone on them from small barges. One of these mats could be made and sunk in the same day with the untrained labor then employed. Their cost per square was $12, and per lineal foot of bank protected, $18.

"A modification replaced the grillage of poles and the connecting pin by a wire netting. This netting was formed on a drum attached to the weaving barge or ways, and on it was placed the brush, and, above the brush, wires which were connected through the mat, forming a very compact and strong revetment, some of which lasts to the present day.

" The work thus far described is submerged ; it was placed in the low water season, and, after being sunk, remained constantly under water.

" It was at first supposed that protection below the low-water line would secure the upper portion ; but it was found that the upper bank quickly washed down, and in many places the mats were flanked by the current. In order to prevent this destruction and make the revetment complete and effective, the upper portion of the bank was graded by hand, and on the slope was placed a shore mat built of grillage and brush, bound by hickory pins and wire, covered with rock, and connected at the water-line with the sub-aqueous work."

It was not until 1879 that steps were taken towards a well-organized project for the general improvement of the lower Mississippi river ; the first being the creation by Congress of the Mississippi River Commission and its appointment by the President of the United States. Its personnel was most excellent, the members being of pronounced eminence as military and civil engineers and statesmen. The duty of the Commission was to have surveys made of the river and obtain data of its physical properties and phenomena on which to base a plan for the work of improvement ; to formulate such a plan or project and to carry it out in accordance with the provisions made by the Government.

The task was a great one and the men to whom it was intrusted were equal to it. Though many changes have been made in the details of the work and greater weight given to certain features that in their incipiency were not considered important, the general plan laid down in the beginning is being in great part carried out in spite of the uncertainty of our method of obtaining appropriations and the enormous and varied forces and quantities involved in the problem. The Rhine, the Rhone, the Danube, the Volga, and many well-known American rivers on which regulation and general improvement has been applied, are of much smaller dimensions and volume of discharge, therefore they were but poor criterions to follow. The processes and apparatus adopted for obtaining the physical data are well known by engineers. Velocity and discharge observations were made at first by floats and rods and afterward by current and direction meters. Depths were found with the lead and graduated line, etc.

The phenomena observed and the laws or supposed laws deduced, which indicate the underlying principle that has to be subserved in the plans for improvement, have been profoundly studied by the engineers employed on the river, and numerous monographs have been written that are of untold value and importance to engineering literature.*

To quote again from the *Engineering Magazine*, June, 1896 : " The Mississippi in its lower reaches, from Cairo to the Gulf, is purely an alluvial stream, flowing through a low-lying land subject to overflow. Its high-water season may be approximately stated as continuous from February to May inclusive, and the low-water season from September to December, the other months of the year marking the transition periods. Its numerous bends have no uniformity of radius or depth, each with its accompanying bar on the convex shore, terminating in a shoal or crossing where the curve is reversed and the water cuts through the continuous chain of sand.

"The banks are formed of strata of sand, buckshot, and clay, of varying thickness. During the high stages the water scours the bank on the concave side in the bends, depositing the material thus obtained on the bar. At low water the reverse is the case to a great extent ; the bar is scoured, and the caving in the bend is materially reduced.

"In accordance with the law of transportation of material in mechanical suspension in alluvial streams, as the water leaves the bend and crosses to the other side with its load of sediment, the heavy grains of sand drop to the bottom and are rolled along in well defined waves, with long up-stream and steep down-stream slopes, the lightest material floating until the velocity is reduced and flow is more uniform, *i. e.*—freer from upward currents and boils, which support the material in suspension—when it is also deposited, the more finely comminuted particles being carried out to sea, where freedom from currents and salt water hasten its precipitation.

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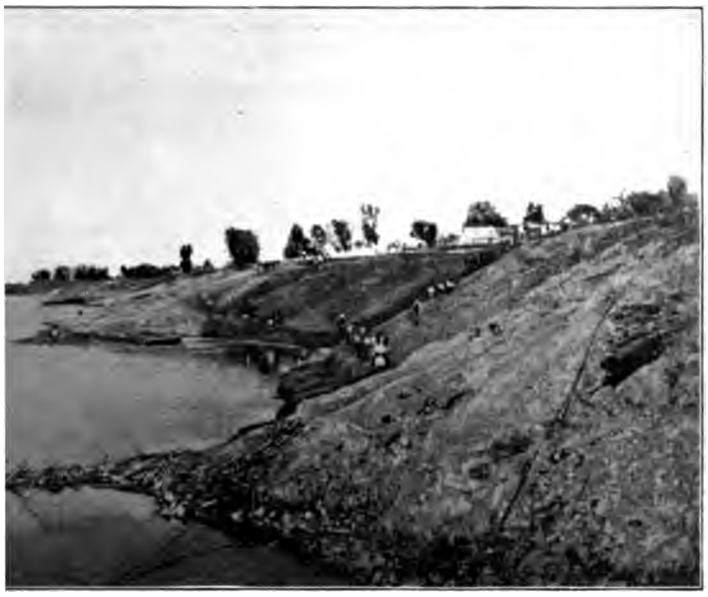
* Papers by Colonels Comstock and Suter and Majors Starling, Ockerson, Seddon and others, in reports of the Commission and Transaction of the American Society of Civil Engineers.



BANK BEFORE CAVING.

" There are, generally speaking, two methods for the improvement of alluvial streams—canalization and regulation.

" The former, owing to the greater cost and difficulty of obtaining permanent foundations for locks and dams, is rarely resorted to, though in latter years the use of concrete has enlarged its field of possibilities where formerly deemed impracticable.

" Regulation includes two distinctive features in streams subject to overflow, governed by the high and low-water regimen. They are: the improvement of the high-water channel, and the improvement of the low or medium stage channel. The former consists in the construction of levees and high-water cross-dikes; and the latter in revetment and spurs for bank protection, permeable dams and training walls, sills (grund-schwellen),* and dredging.

" In some foreign rivers portable jetties have been used, but not on any extensive scale.*

" These different methods have been differently employed on many rivers throughout the world, with a varied measure of success, their application being accompanied in different localities by modification in detail of structure, governed by the material at hand and the judgment of the designing engineer.

" The great discharge of the lower Mississippi river, the excessive oscillation of its water surface from high to low gauge, the vast destructive energy stored and expended in its flow, and the crumbling or friable nature of its banks, makes the problem of its regulation or improvement, both for the protection of property and benefit of navigation, a very difficult one to solve."

The original plan of improvement adopted by the Mississippi River Commission was as follows:

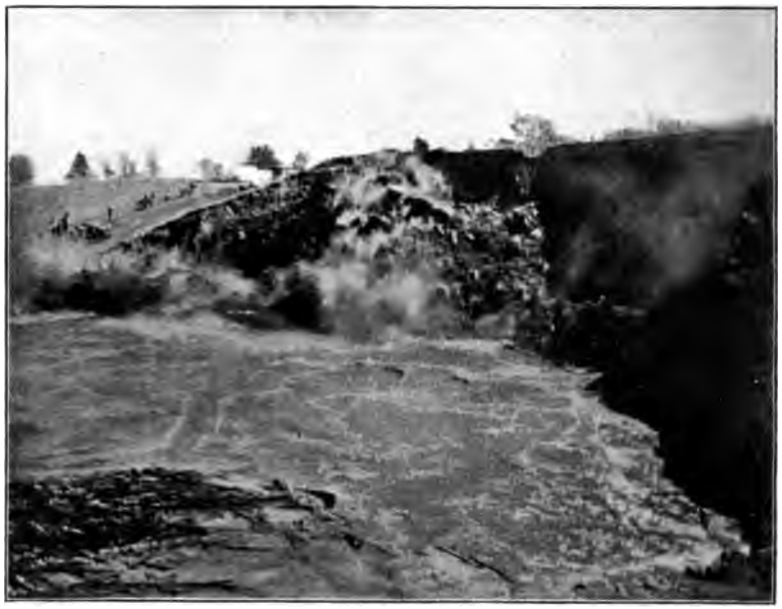
First, to control the floods or high water by levees.

Second, to contract to a normal width the wide reaches by permeable and impermeable dikes.

Third, to protect the banks from caving by revetments.

This plan has been changed as follows:

First, the use of contraction works has been abandoned to a great extent. Few dike or training walls are now constructed.



SAME BANK CAVING.

Second, the general improvement of the river by bank protection, revetments, spurs, etc., has been postponed until some less expensive structures are designed or discovered.

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* Also called by the French Epis Noyes.

* See Prof. J. Schlichting " Navigable Non-tidal Rivers." (Morath's movable floating spur, used in Germany.)

Third. The existing revetments are being repaired and new ones placed in localities where cut-offs and out-lets threaten the stability of regimen, or harbor lines and valuable city property are being encroached on by the caving banks.

Fourth. The low-water channels over the crossings are being maintained by dredging during the low-water season.

The lower Mississippi gets its water principally from two great drainage basins or watersheds, the Ohio and the upper Mississippi and Missouri. The former is about 200,000 and the latter over 700,000 square miles in extent, and though the latter is over three times greater its average annual discharge is but one-half that of the former. In the lower reaches the flow is augmented by the discharge of the St. Francis, the Arkansas and White, the Yazoo and the Red rivers; the Arkansas, White and Red adding at flood stage over 750,000 cubic feet per second. The St. Francis and Yazoo are of little consequence, except in that their basins act as relief areas or reservoirs during high stages of the river. The drainage basin of the Arkansas and White is about 200,000 square miles, nearly as large as the Ohio, and that of the Red river 99,000 square miles.

The rains that produce our greater floods are precipitated on the slopes of the Ozark mountains and the watershed supplying the Ohio, Cumberland and Tennessee rivers. The destructive storms that pass up from the Gulf of Mexico, commencing in February, deposit part of their burden of moisture on the hills and valleys tributary to the Arkansas and White and in the main trunk basins of the lower river. Continuing up through the Ohio valley to the topmost ridges of the Appalachian chain, they pour down floods of water that in great part reach the alluvial river, causing destructive overflows. As a rule, the high water from the Missouri and upper Mississippi does not come until late in the season, when the spring flood has passed from the Ohio valley and the lower Mississippi is in condition to receive the discharge.

The lateness and the lack of importance of these latter floods is due to the fact that the drainage basins of the upper Mississippi and Missouri are in an arid region of little rain-fall, and that they are geographically situated in such northern degrees of latitude as to keep their waters practically frozen until late in the spring.

At first, owing to the narrow interpretation of the law governing the application of the funds appropriated, levee construction was not given a very important place in the general work of improvement. Later it has become the most important feature, not only as a means of channel regulation but as a protection to the alluvial lands and the people living thereon.

For convenience of administration the Mississippi River Commission divided the portion of the alluvial basin from Cairo to the Gulf into four districts, each of which is placed under the supervision of an officer of the United States Engineer Corps. These districts include the levees built by the local, state and county boards, which are to a great extent, maintained by the Government.

The first and second districts, extending from Cairo to the mouth of the White river, have been consolidated and are under one officer.

The third district reaches from White river to Warrenton, just below Vicksburg, and the fourth thence to the head of the passes.

The climate varies but slightly in this entire reach of river, the winter in the upper districts being more severe and extended, but the other seasons partaking of practically the same changes. The high-water conditions are much the same, varying in average height of overflow and time of maximum gauge reading. The topography is similar: a flat alluvial plain intersected by numerous bayous and lakes, old river arms, etc., having slopes gently declining from the river and in the direction of its flow.

The materials composing the banks, on which the revetments are placed, and the foundations on which the levees stand, and the material of which they are constructed are of the same geological epoch, and, generally speaking, were formed by the same agencies throughout. In the lower district the alluvium is more compact and tenacious, and resists caving better than in the districts above.

Since 1882 approximately 80,000,000 cubic yards. have been placed in the levees by the Government. The form of these levees has varied with local conditions, but since 1887 the general specifications have not been radically changed.

A few years ago the Government adopted standard sections which have since been adhered to, except in cases where the conditions demanded more specific treatment. The first, second and third districts have practically the same standard for all levees on all ordinarily good foundations, and when constructed of material not below the average in strength.

The standard dimensions are: Crown, 8 feet; front or river slope, 3 to 1; back slope, 3 to 1. Where the levee is over 11 feet in height, a banquette, at an elevation of 8 feet below the top of the main levee, is added. The slope of the crown of this banquette is 10 to 1, width of crown 20 feet, and back slope 4 to 1. Where the foundation is bad or the material is weak, the banquette section and perhaps the front slope of the main levee is increased.

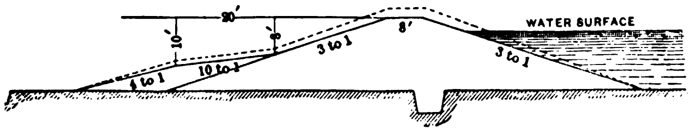


Fig. 1.

The dotted lines in Fig. 1 show the shrinkage section to which levees are built. The specifications require the levee to be constructed in 2-ft. layers with scrapers, on a well grubbed and thoroughly plowed foundation containing a small exploration muck-ditch filled back with strong material, the best to be found in the vicinity, and sodded at 2-ft. intervals with Bermuda grass.

In the fourth district the dimensions vary with the height, and are intended to conform more nearly to the supposed theoretically perfect section. These variations may be further modified as in the other districts when required by abnormal condition of the foundation, material of construction, wave wash, etc.

STANDARD LEVEE SECTION.

For levees from 10 to 15 feet in height the crown is 8 feet, the river slope is 3 to 1, and the land slope 4 to 1 to within 5 feet of the crown; thence to the crown it is 2.5 to 1.

For levees from 15 to 20 feet in height the crown is 8 feet, the river slope is 3 to 1, the first 8 feet of the land slope from the ground is 6 to 1, the next 6 feet 4 to 1, and thence to the crown 2.5 to 1.

Fig. 2 shows these sections and the method of placing allowances for shrinkage.

In the upper districts 10% of the height, both in wheelbarrow and team work, is required for shrinkage.

These standard sections are expected to withstand the water to within 3 feet of the crown of the levee,

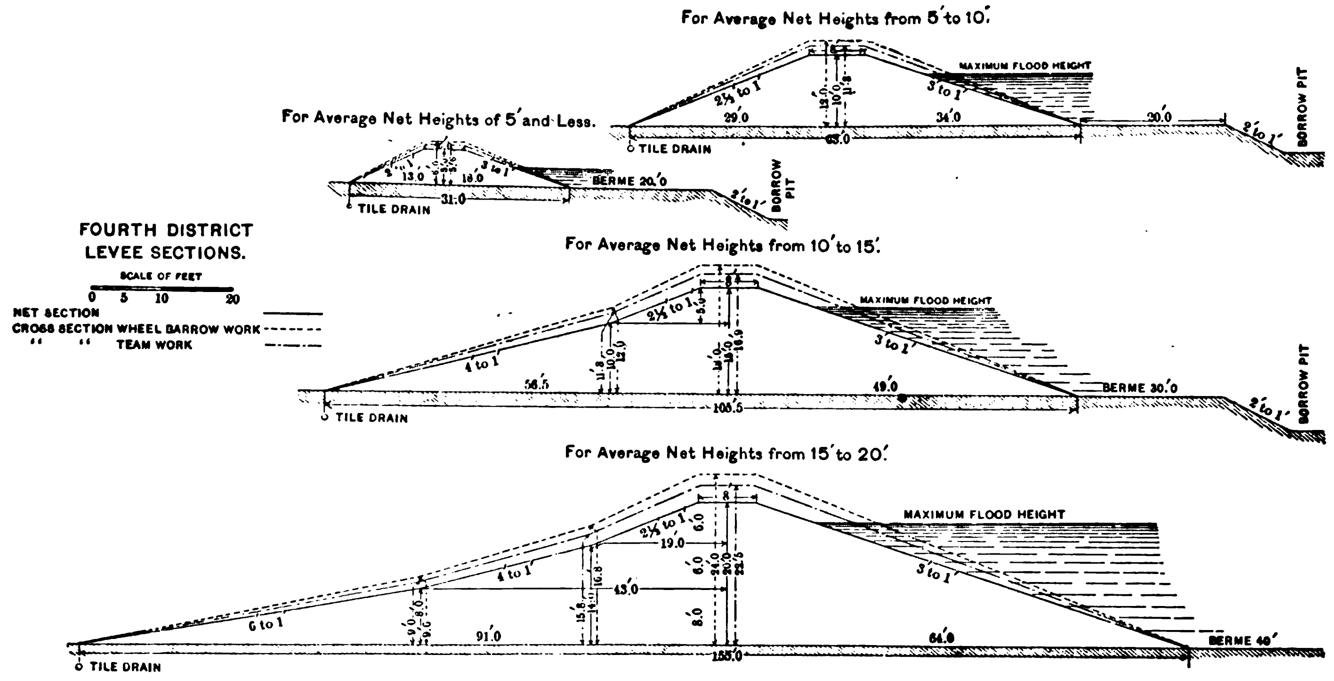


Fig. 2.

without excessive saturation or change of form, and to give unqualified protection under all normal conditions of foundations and materials of construction.

When subjected to water above the 3-ft. line, though they are intended to remain intact they cannot be considered, either theoretically or practically, standards of excellence.

In June, 1898, the writer published a paper in the Transaction of the American Society of Civil Engineers, entitled "Standard Levee Section," in which the sections of foreign levees are compared with those adopted in this country. It is interesting to note that the experience on the Mississippi river is parallel to a great extent with that in Holland. Eliminating the portion of the levee used as a roadway, we have a theoretical section very similar on both sides of the ocean.

LEVEE UNDER CONSTRUCTION.

In both continents the same problem was worked out with very much the same means, and to the same results. Abroad, more time and money are expended on revetments to protect the exposed slope of the levee than in this country, but not until the required grades and sufficient material have been obtained here will the question of levee revetments become vital, except as very unusual departures from the general practice.

During the flood of 1882 and those prior to that year the levees were very weak and imperfect, offering but feeble resistance to overflow. In 1882 the discharge was probably as great as that of any known flood. It was in the neighborhood of 2,000,000 cubic feet per second.

Since 1882 with the growth of the levee system with Government assistance, and the gradual elimination of reservoirs, and contraction of high-water sections, the flood plane had risen, each high water for a given volume of discharge giving greater gauge readings. In 1897 when the volume of discharge approached very nearly to that of 1882, the water climbed above the crown of the levee and continued to rise against the temporary topping, that was hastily placed in the emergency of the moment, until it overcame at many points this feeble resistance, and relieved itself in the great basins to east and west. The following table gives the difference in elevation on the gauges, of the floods of 1882 and 1897:

	1882.	1897.
Cairo	51.9	51.6—0.3
Belmont	45.1	45.1 0.0
New Madrid	40.9	40.3—0.6
Cottonwood Point	37.5	39.3+1.8
Fulton	36.7	37.5+0.8
Memphis	35.2	37.7+2.5
Mhoons	39.8	41.6+2.8
Helena	47.2	51.8+4.6
Sunflower	41.7	47.3+5.6
White River	48.4	52.4+4.0
Arkansas City	47.1	51.9+4.8
Greenville	41.7	46.8+5.1
Lake Providence	38.3	44.4+6.1
Vicksburg	48.8	52.4+3.6
St. Joseph	44.9	47.9+3.0
Natchez	47.8	49.8+2.0
Red River	48.5	50.2+1.7
Bayou Sara	39.3	43.8+4.5
Baton Rouge	36.0	40.7+4.7
Plaquemine	31.3	36.3+5.0
College Point	23.2	28.0+4.8
Carrollton	15.0	19.0+4.0

With the experience derived from the latter flood estimates have been made, based on scientific research, and the general consensus of engineering opinion is that a levee grade about 6 feet above the high water of 1897 will be safe against any flood that it may be necessary to contend with.

The levees of the lower Mississippi are about 1,800 miles in length; a few gaps remain to be filled before the system is continuous, except where the hills approach the river and at the mouths of tributaries, where leveeing is impossible. Fig. 3 shows the position and area of the basins protected, and the following table gives the districts, their length, and the amount of cubic yards of material in the levees April, 1898:

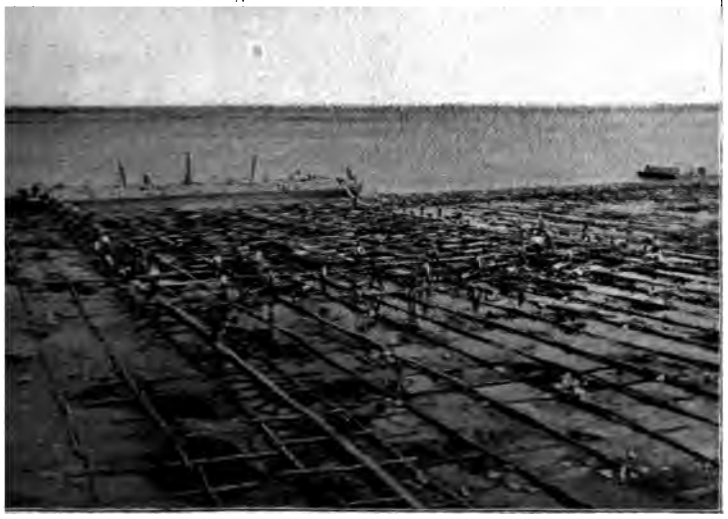
Districts.	River length to be protected.	Yardage April 30, 1898. Total existing Levees.
	Miles.	*Cubic Yards.*
Lower St. Francis	218	7,039,424
Upper Yazoo	121	14,682,166
White River	80	6,356,364
1st and 2nd Districts	419	28,077,954
Lower Yazoo	230	26,256,857
Upper Tensas	205	24,042,150
3d District	435	50,299,007
Lower Tensas	160	14,417,288
Atchafalaya	122	15,448,446
Lafourche	71	6,945,622
Barataria	92	2,379,813
Homochitto	238	
Pontchartrain	116	11,982,558
Lake Borgne	82	2,635,932
4th District	881	53,809,659
Grand Total	1,735	132,186,620

Since April, 1898, about 5,000,000 cubic yards have been added, making a grand total of about 137,000,000 cubic yards in all the levees on the alluvial river.

In order to complete the system to the ultimate grade averaging about 6 feet above the high water of 1897, the Mississippi River Commission asks for $20,000,000 to be appropriated by the Government.

In the work of the Mississippi River Commission after 1882, the duty of revetments was materially extended.

Instead of protecting harbor fronts in limited spaces, they were employed to retain the bank in long and difficult reaches. To meet these new conditions an entire change in construction was necessary.



BALLASTING MATTRESS,

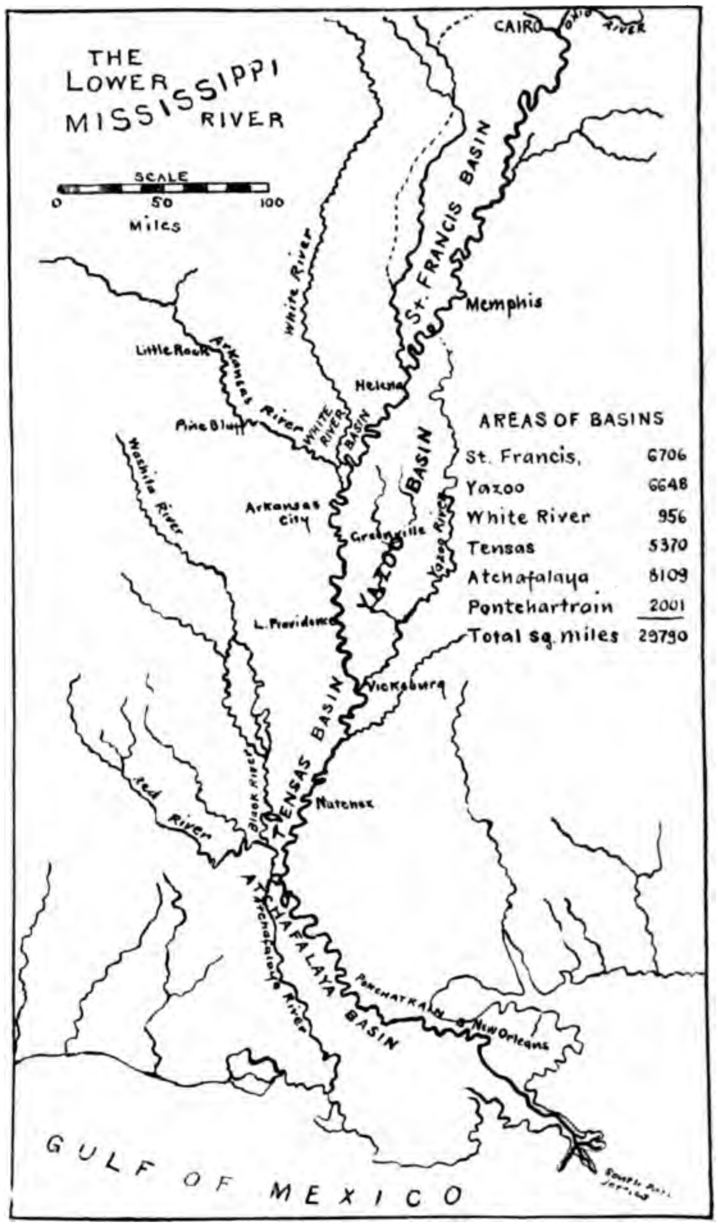
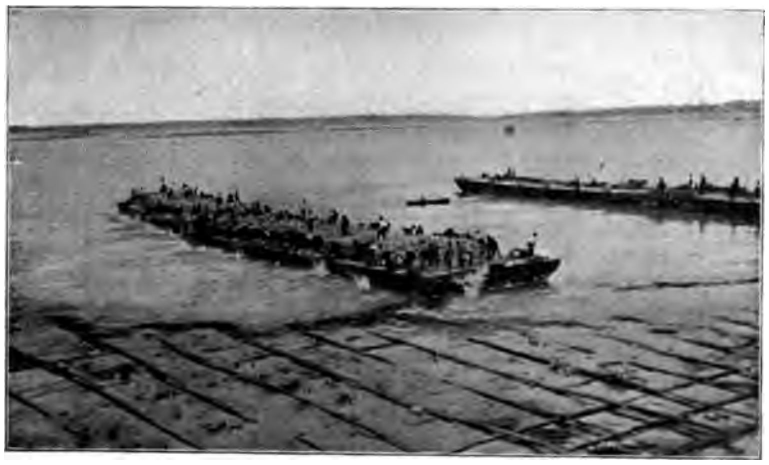


FIG. 3.

The woven mat was adopted and continued to be the standard for many years, and many localities were permanently and successfully protected by it.

It was constructed by first building on floating ways a rigid head of poles, to which weaving poles were fastened at right angles. On these weaving poles, extending to the full length of the mat, was woven willow brush. A grillage of poles was fastened to the top, and, after being secured to the bank and mooring barge, the mat, 400 feet long by 150 feet wide, was sunk by means of rock thrown from barges.



SINKING MATTRESS.

After sinking the mat the upper portion of the bank was graded to a slope (3 horizontal, 1 vertical) by the hydraulic method. The grader consisted of a large duplex compound pump with a capacity of 2,000 gallons per minute, giving a water pressure of 160 pounds, with a steam pressure of 80 pounds per square inch and a vacuum of 26½ inches. It rested on a house barge. The hose from the pump terminated in a 1¼-inch nozzle, from which the water was directed against the bank, reducing it to the required grade. The excavation of 1 cubic yard of earth took a fraction less than 1 cubic yard of water, and used three pounds of coal.

Owing to the heterogeneous consistency of the bank, the slope, as left by the hydraulic grader, was often very unsatisfactory and rough.

This had to be remedied by hand, sluice, and scraper dressing, before revetting. The height of bank graded averaged about 30 feet, and the material excavated per hundred feet about 3,500 cubic yards, costing about 4 cents per cubic yard for removal.

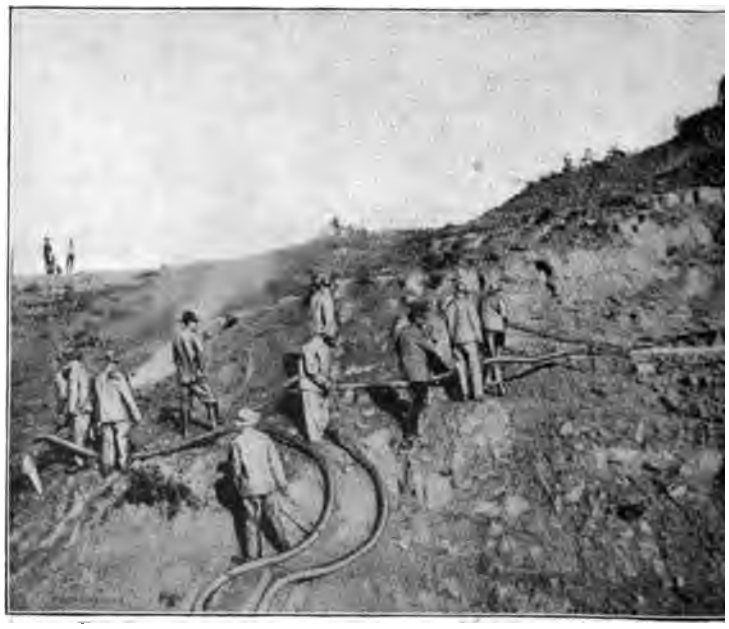
When the bank was dressed a revetment of two layers of brush with pole grillage above and below, fastened with wire and spikes, was placed thereon and well covered with stone.

This type of bank protection with numerous modifications has been used up to within a few years, and has proved in many places very successful. The size of the mattress was considerably increased, being as much as 2,000 feet long and 300 feet wide. The thickness was also increased by overweaving and cross-weaving and the additions of loose brush under top grillage. Greater strength was obtained by the introduction of iron rods, longitudinal and transverse cables, and hard-wood heads. In the early and insufficient work the cost per lineal foot of bank protection was $14; the later standard woven mats, 300 feet wide, with paved bank, cost $30.

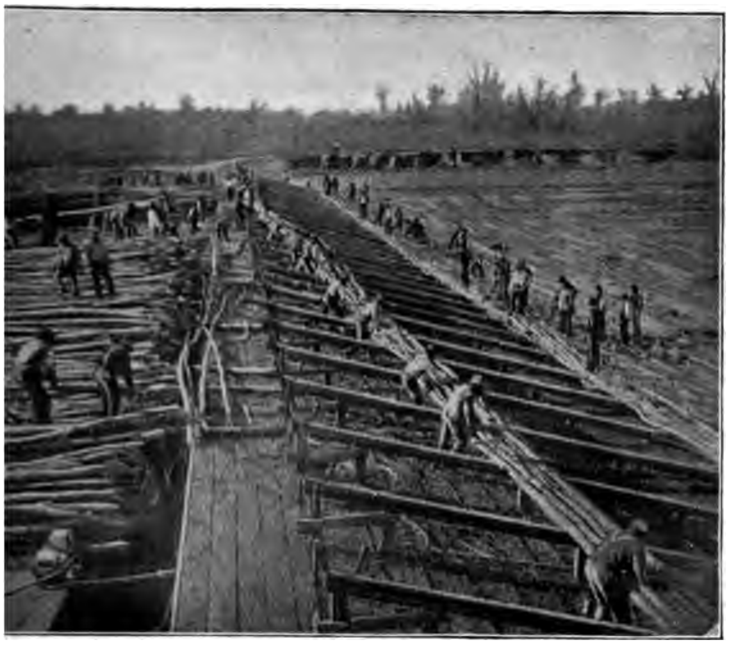
Notwithstanding the fact that additional strength and thickness had been given the woven mat, it was found that the water would scour the bank through the spaces between the willows, and, owing to its stiffness, the mat was often damaged at the outer edge where the action of the current was violent. To prevent this, and to obtain a structure both stronger and more pliable, the fascine form was tried, and proved so superior to the old mat that it has been adopted as the standard, and bids fair to solve the problem of permanent protection at all points and in all materials.

The fascine mat is made with about the same dimensions as the large woven mats, 300 feet by 1,000 feet. It is constructed in the following manner:

First, a large head of hard-wood poles, 3 feet in diameter, is formed on the ways normal to the bank. To this head is fastened, at intervals of 8 feet, a ⅕-inch wire cable and a ¼-inch wire strand. Fascines about 11 inches in diameter made of bundles of willows are then placed parallel to and against the head, being forced well up to it and held in place by a turn of the wire strand and a clamp on the under cable. When 10 feet (in length of the mat) of the fascines have been placed, a second hard-wood head is constructed, taking the place of a fascine, and clamped in the same manner. These two heads form the head of the mattress, to which



HYDRAULIC BANK GRADING.



BUILDING FASCINE MATTRESS.

the mooring and shackle lines are attached, as well as the cables of wire strand. After the head is formed the fascines are made and clamped into position so tightly that no spaces are left; indeed, the work is so compact that it will gradually sink from accumulation of silt. Transverse cables are also used, strengthening the mat and connecting it at intervals with the bank. On the top of the mattress are placed longitudinal poles fastened every 5 feet to the fascines with No. 7 Silicon bronze wire. After completion the mattress is first ballasted by loading it with rock, carried in wheelbarrows, until its flotation is nearly destroyed; then it is sunk in the usual manner, by floating barges over it and throwing rock on it, in large quantities, by hand.

In the later work the upper bank is graded to a slope of 4 to 1, and on it is placed a pavement of rock and spalls carefully laid, instead of the willow shore mat, which is destroyed by natural decay in about three years.

There is a marked difference in the kinds of revetment that have proved successful in the river above the mouth of Red river and below, due to the fact that, below the slope and width are less and the average depth greater. No obstructive bars or crossings occur, the caving is comparatively slight, and the range from high to low water at New Orleans is but one third that at the mouth of the Arkansas. The velocity of the current at low water is very slight, and the radii of bends much greater as a rule. Interrupted revetment and dikes can be used in the lower river with much better results, and much weaker and lighter structures can be made effective.

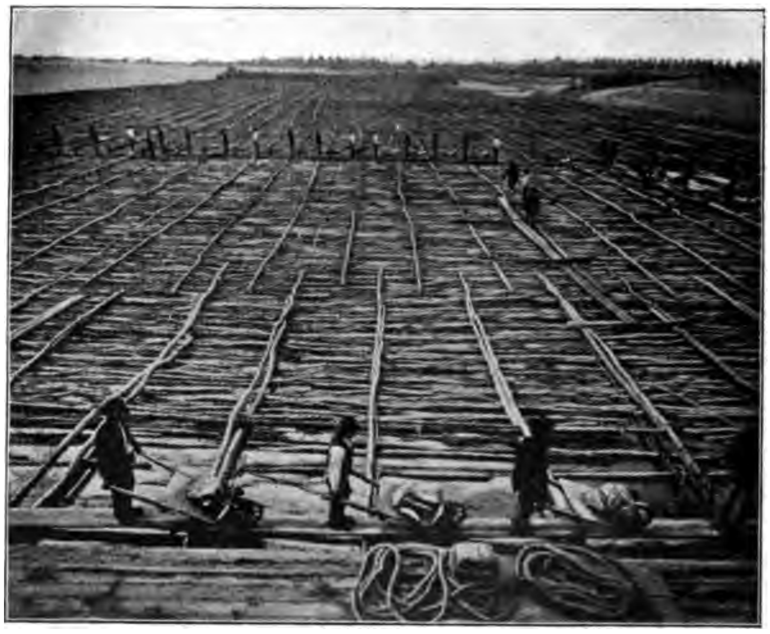
It is in the vicinity of New Orleans that the first submerged crib dikes were placed as a protection to the city front. They were located at intervals of about 500 feet, being placed on foundation mattresses at first woven, afterwards of the pin and frame type. The foundation mattress was generally about 350 feet by 200 feet, with long axis normal to the bank, sunk between mooring barges with rock.

The number of cribs composing the body of the dike varied with the depth of the water and the conformation of the sub-aqueous slopes.

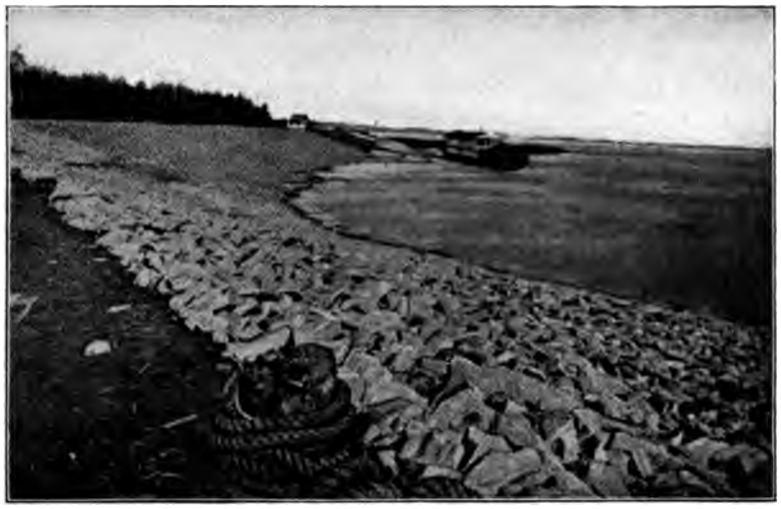
The cribs were made of sawed timber frames, connected by long iron bolts and wooden posts fastened with wooden pins, between which and forming the body of the crib was placed willow brush, pockets being left in the construction in which to place the rock for sinking. The mattress required about 7 pounds of rock to each square foot of surface, the cribs about 7 pounds for each cubic foot of structure.

The cost averaged about $7.60 per square foot for mattress, and 3¾ cents for crib per cubic foot. In the upper river the crib work is carried to the top of the bank by framed structures similar to the submerged portion; in the lower river by an earthen levee paved with rock.

Chief among the difficulties to be contended with in the work are the drift and snags. As the bank



FASCINE MATTRESS COMPLETED.



PAVED BANK.

caves, in the wooded reaches, it carries into the water large trees that for a long time remain upright in the river, forming snags over which it is impossible to sink mattresses. These are removed by powerful snag boats and explosives manipulated by divers.

When a partially constructed mattress, say 300 feet wide and 800 feet long, is in the water at the time of a rapid rise, much drift will accumulate at the upper side of the mooring barges, necessitating the use of great numbers of mooring cables. Sometimes the pressure becomes so excessive that it is impossible to contend with it, and the mattress is torn from its moorings. The pressure in a current 8 feet per second against a mat head extending 300 feet out in the river with drift lodged under it to a depth of 15 feet is very difficult to counteract.

In the foregoing description of bank protection, two distinctive types of construction have been noted, continuous revetment and submerged spurs. The former offers little resistance to the flow of water, but the latter causes reverse flow and the checking of the current, thus producing a deposit in the unprotected intervals, when effectual. In bends of great radius, light currents, and strong bank material, the spurs have proven very beneficial and permanent, placed at intervals of about 500 feet; but in abrupt bends in light soils, even at reduced distances, they are unsatisfactory. Unlike the continuous revetment they obstruct the inshore channel, offering resistance to flow and changing the mechanical forces of the river from potential to active work which, if strong enough, means destruction of the structure or the bank beneath it. In some localities in the upper river they have been destroyed, or have sunk into pockets formed by the current, and the unprotected spaces have been attacked, necessitating the application of continuous revetment.

The following table gives the materials used and the cost of dikes and standard revetments, used up to 1897 below Cairo. Since 1897 there has been practically no change in form and but slight reduction in cost.

MATERIALS.

KIND OF PROTECTION.	Brush, Cords.	Poles, Cords.	Stone, Cu. Yds.	Wire, Lbs.	Cable, Lbs.	Spikes, Lbs.	‡Cost.
*Woven Mat. per Lin. Ft.	2.025	0.41	6 14	22.97	13 6	......	$29.07
†Fascine Mat. per Lin. Ft.	4.48	0.17	7.76	11.50	36.04	3.7	30.04
Crib Dikes per Cu. Ft.	0.44	0 24	Tons 0.55	0 12	0.007	......	3¾c

*Mat. 250 ft. wide stone pavement.
†Mat. 300 ft. wide stone pavement.
‡Cost includes labor.

The early mats cost per square	$12.00	approximately.
The standard woven mats per square	4.50	"
The frame mats, New Orleans, per square	9.00	"
The fascine " " " " "	6.00	"
Brush shore revetment, New Orleans, per sq.	6 00	"
Pavement per square	10.00	"
Crib work of dikes per cu. ft	.04	"
Grading with hydraulic grade per cu. yd	.04	"

DRIFT AT HEAD OF MATTRESS.

To build and sink a fascine mattress 300 feet wide requires from 250 to 300 men, and the average progress per day is about 150 lineal feet. Of the finished cost, about 45 per cent. represents labor and 55 per cent. material.

It must be borne in mind that the structures described may be similar to some extent in form and construction to those employed on other rivers, but their dimensions and the conditions under which they are placed are vastly dissimilar. No revetment work in the world approaches the magnitude of that accomplished on the Mississippi, in the way of bank protection. Here mattresses with superficial areas of seven and eight acres are sunk to the bottom of the river in depths of 80 and 100 feet, in currents of from 5 to 8 feet per second; and dikes 430 feet long by 60 feet high, each containing 80,000 ft. of lumber, 2,000 tons of rock and nearly ten tons of iron (iron rods and nails) are similarly placed in 150 feet of water.

The work of the Mississippi River Commission thus far accomplished has demonstrated the feasibility of ultimately controlling this mighty river and training it between permanent banks, without either raising its bed or destroying the great agricultural domain adjacent thereto, but this result can be obtained only by the expenditure of a large sum of money.

CONSTRUCTING SUBMERGED SPUR.

It is now conceded by many engineers familiar with the problem that, in order to obtain the best results, the permanent work should commence at the head of the alluvial river and be extended down stream from year to year until the entire channel has been regulated, local works, which would ultimately form a part of the continuous system, being carried on for special purposes from time to time.

By a system of bank revetment or other protection commencing at the head of the alluvial basin is not meant a continuous revetment irrespective of general physical or topographical features; these, of course, will be potent factors in the problem, and will have to conform to certain limits, the river being allowed to cave at certain points until given degrees of curvature, slope, etc., obtain, and the effort being to obtain as great a length of river and as light a slope as possible, so that when the bar building ceases, the conditions of depth and flow will conform more nearly to those existing below the mouth of the Red, where navigation is safe and permanent.

In order, therefore, to improve the river as a whole from Cairo to New Orleans, some caving bends would be passed by (though the general plan would be to protect each), and many isolated reaches would be revetted, irrespective of the continuous work.

In the present river from Cairo to the mouth of the Red, there are * 406 miles of caving bends. By making allowance for additional caving produced by new work, and eliminating the banks where protection may be unnecessary, the distance will not be materially changed.

The cost, at the present rate, for the most effective means of protection—$160,000 per mile—would be, roughly estimated, $67,000,000. Adding 10 per cent. for repairs and plant, the total cost of permanent bank protection becomes $73,700,000.

In addition to the permanent work, the proposed dredging would cost, in twenty years, in accordance with Col. Henry Flad's estimate for a channel of 250 feet wide and 9 feet deep at low water from Cairo to Natchez, as follows:

For plant	$1,188,000
Dredging	6,996,000
Total	$8,184,000

Adding to the amount necessary to protect the levee system $20,000,000, we have the following approximate total for completing the improvement from Cairo to the Jetties:

Permanent channel improvement	$73,700,000
Levees	20,000,000
Dredging	8,184,000
Total	$101,884,000

When the Mississippi River Commission decided to employ dredges to improve low-water navigation the first problem to be solved was that of the best form of dredge for the special duty of taking the sand from the crossings and moving it beyond the new channel quickly and economically. The dredges in use throughout the world were:

Scraper and sluicing dredges (including hydraulic and pneumatic sluices), dipper or scoop dredges, clamshell or grab dredges, bucket ladder or endless chain dredges, hydraulic dredges.

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*See report of the Mississippi River Commission for 1896, page 3458.

Each of these types has numerous modifications to suit the special conditions and purposes for which it is designed, differing in form of rake, jet, bucket, grab, hopper, machinery, hull, etc. In some there is a combination of two types, while in others the variation from the parent form is marked, as in the pulsometer, pneumatic scraper, etc.

The difficulty of applying economically the above-mentioned dredges on the bars of the Mississippi lies not so much in their inadequate excavating power as in the means of conveying the dredged material the necessary distance from the dredged channel. The real problem to be solved, therefore, is not alone that of excavation, but that of conveying dredgings in this wide river subject to so numerous varying currents and strong winds. That the last and more modern type of dredge is better fitted for this work is self-evident. The reduction in lift and economy in operation on a large scale cannot be doubted. Its double function of conveying as well as excavating fits it especially to this particular project.

The simplest form of the pump or hydraulic dredge is shown in Fig. 4.

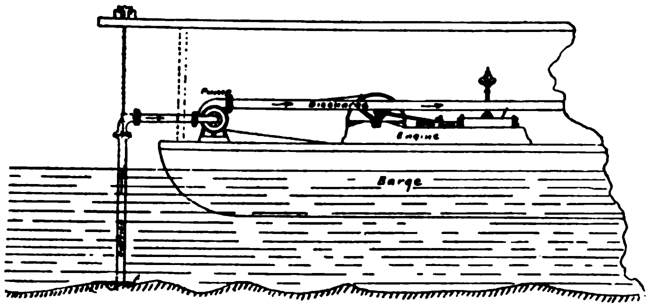


Fig. 4.

Here we have a small centrifugal pump run by a belt from a small engine, a suction pipe of iron and rubber, and the discharge. When the pump is in action the water and sand are drawn from the bottom, pass through the pump, and are forced through the discharge opening to a distance governed by the length of pipe, power of engine, capacity of pump, height of dumping ground, etc. The centrifugal pump differs from the ordinary reciprocating pump in that it is valveless and can take up and discharge large quantities of water containing large percentages of foreign matter without detriment to its parts. It consists of an iron shell or box, through which a shaft works; on this shaft and in the shell is a runner with blades, fixed or adjustable, forming a species of fan. On the shaft outside the shell is a pinion or gear, by which connection is made with the engine. The water and material is taken into the pump at base or center of the fan wheel, and discharged at right angles to the suction and at the outer edges of the blades.

These pumps are made of various patterns, sizes and capacities. One lately designed for the partial drainage of New Orleans is nearly 12 feet in diameter and has a capacity of 1,900 cubic feet per minute.

It is claimed that Bamath, Hoffman & Schwartzkopf, a German firm, first patented the hydraulic dredge in 1856. Mr. Bowers, of California dredging fame, was also a pioneer in hydraulic dredging, but probably the first application of the pump for transporting dredged material was as late as 1867, on the Grand canal at Amsterdam, the capacity of the pump being 1,330 yards per 12 hours, conveyed 900 feet and lifted 5 feet.

In 1872 General Gilmore, of the United States Engineer Corps, operated a crude suction dredge at the mouth of the St. John river, Florida, which moved 78 cubic yards per hour at a cost of about 31 cents per yard. In 1877 Captain Eads designed a hydraulic dredge which worked at the mouth of the Mississippi. The Van Schmidt dredge of 1883 was the first complete hydraulic machine of large capacity and delivering design used in this country, and is a good illustration of the truth that "necessity is the mother of invention."

From these beginnings in the near past have been evolved the great hydraulic dredges, too numerous to mention, that have developed enormous capacity for excavation and delivery of material (in sea, river and canal), of various forms, from the stationary pulsometer used on the Potomac flats to the sea-going hopper dredge with mammoth rotary pumps, each varying in general design and detail with the conditions under which they operate.

To move vast quantities of sand in a short time and deliver it from 1,000 to 2,000 feet from the channel required a new departure. In 1894 and 1895 a dredge was constructed by the commission which, though a success, was but a step to the great hydraulic machine which followed the next year, and with its consort kept the river open to navigation during the low-water season of 1896. The first dredge was named the Alpha. It was designed after careful experiment and investigation had demonstrated the proper dimensions, power and capacity for its machinery and frame, and has proved a success, though of much less capacity than the later dredge, Beta, which is probably the largest and most complete hydraulic excavator in the world to-day. The dredge Gamma at work is shown on this page. The plant accompanying this dredge consists of one large steam tow-boat, one pile-driver and three barges.

DREDGE GAMMA.

The report of her operations during the season of 1896 gives the cost of material (sand and gravel) moved as 4.3 cents to 12.1 cents per yard, the latter due to break down in runner of main pump.

At one crossing, Compromise Bar, 77 miles below Cairo, the work consisted of 7 cuts, aggregating 5,405 lineal feet, the dredging time being 257¾ hours, and the average rate 21 lineal feet per hour. The amount of material moved was 80,555 cubic yards= 312½ cubic yards per hour. The cost was $3,-473.68 ; average cost per cubic yard 4.3 cents (sand and gravel).

The Beta, though similar in general conception to other hydraulic dredges of the day, differs much in size and detail. Strictly speaking, it consists of two separate dredges on one hull, each with cutters and suction openings leading to a separate suction, large centrifugal pump, and discharge. The hull is of steel, 172 feet long, 40 feet broad, and from 7 feet 2 inches, to 10 feet 10 inches in depth. About midship of the hull are located two centrifugal pumps, one on each side, each, as stated, acting as a separate and complete hydraulic dredger. Each pump has a runner 7 feet in diameter and shaft 10 inches in diameter, with discharge 33 inches and suction 33¾ inches in diameter, actuated by separate, triple-expansion engines with high-pressure cylinders 20½ inches, intermediate 33 inches, and low-pressure 38 inches in diameter, with 24-inch stroke. Each engine has jet condensers. Steam is obtained from four 375-horse-power Heine boilers, placed as shown in the drawing.

The six suctions, three to each main suction pipe, are 19½ inches in diameter. At the end of each suction pipe there is a revolving cylindrical cutter 5 feet in diameter, which cuts up the material to be inhaled by the great pumps. Each suction pipe is partially buoyed by a pontoon. The cutters are actuated by a small engine placed at the extreme bow of the dredge, which gives the cutters a speed of 25 revolutions per minute. The average speed of the centrifugal pumps while working is from 125 to 130 revolutions per minute.

The machinery for hoisting the suctions and cutters and regulating the movements of the dredge is shown just aft the cutter engines.

Two vertical spuds for holding the dredge in place, and one pushing spud, are situated astern, and are moved by a small three-drum hoisting engine. The discharge or pipe conveyor is about 1,000 feet long, extending from the stern of the dredge to the dumping ground. It consists of 50-feet lengths of 33⅓-inch steel pipe, resting on steel pontoons ; the pipes have rubber hose connections, and are also connected and held in place by steel bars. When the dredge is operating the pontoons are almost completely submerged. The power generated by the machinery on this dredge is more than 2,500 horse-power and her weight is more than 1,000 tons.

DREDGE BETA.

An electric plant of two 4,000 candle-power searchlights and forty 20 candle-power incandescent lights enables the dredge to work continuously at night. The dredge has a traveling crane, blacksmith shop, and all the outfit required to work at a distance from the point of supply.

DREDGE ALPHA.

The following is the manner of operating: After being placed at upper or lower edge of crossing by her attendant steamboat, her spuds and cutters are lowered to hold her in place. Two clusters of piles are then sunk up stream on the line of proposed dredging extended, and cables are run from these piles to drums on the dredges. Piles are then sunk for guiding the line of discharge-piping and keeping the dump well removed from the cut. When these operations are completed, the dredge is ready for work; the spuds are raised, the suctions with cutters are adjusted to the required depth, and the pumps and cutter engines started, the dredge being either dropped backward over the bar, by rendering the cables, or moved forward by means of engines near the bow. The best method seems to be pulling up over one cut and dropping down over the next, and so on, thus economizing time and obtaining the best results.

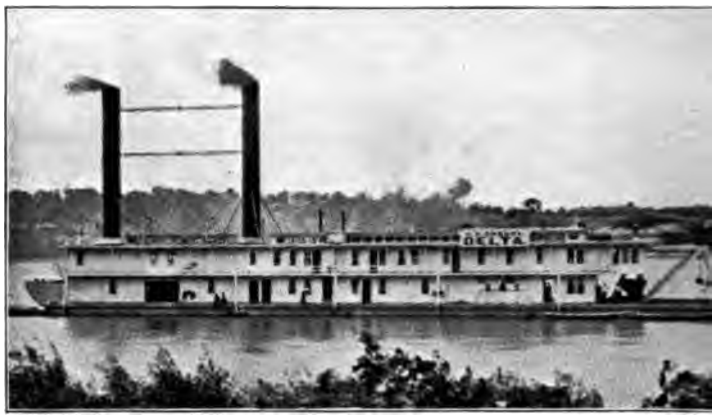
As the centrifugal force and the reaction in the long line of discharge-pipe tends to give a forward and transverse motion to the entire attached floating plant when operating, a baffle-plate is used at the end of the line of discharge to counteract this tendency.

The results of the first tests of this dredge were very astonishing and misleading. The average working capacity proved to be much lower than that which the short-time trials of the contractor had given reason to expect, yet it was far above the working capacity of other hydraulic dredges in the country.

The contractor's tests, which extended over less than ten minutes of actual operation, showed an average velocity of discharge exceeding 13 feet per second, a percentage of solids to gross discharge of 23, and a delivery of 4,921 cubic yards of sand per hour.

The plant for this dredge consists of two steam towboats, one quarter boat, one machine shop, one pile-driver and two barges.

During the season of 1896 this dredge was employed on seven crossings; her record on one near Island 34, 179 miles below Cairo, was as follows: Two cuts were made nearly parallel, 40 feet apart, aggregating in length 2,275 feet; the time for dredging was 66 hours. More than half the work was done without the use of the cutters, the material being sucked up without previous agitation. The rate of advance was 24 feet per hour. The material was coarse sand and gravel. The suctions lowered to a depth of 15½ feet. The number of cubic yards moved was 91,852, an average of 1,392 yards per hour. The total work, including towing, cost $1,793.42, or 2 cents per cubic yard.



DREDGE DELTA.

The percentage of solids to total discharge during the season was about 12. On one crossing this dredge used 89½ bushels of coal per hour. The cost of dredging throughout the season was about 2¾ cents per cubic yard of sand moved.

In 1895 one dredge was at work, in 1896 two, and in 1898 six.

In 1898 Mr. Ockerson, member of the Mississippi River Commission, under whose direction most of the dredge construction and operation were carried on, stated before the Senate Committee on Mississippi River Floods: "The work done by these dredges has demonstrated that a channel can be opened through the bars and that the channel generally maintains itself throughout the low-water season after it is opened." "There is no doubt about our being able to open through the sand bars a channel of sufficient magnitude to satisfy the demands of navigation."

It has been my endeavor to show the conditions existing on the lower Mississippi river, and step by step the methods for amelioration; by levees, dikes, revetments and dredging.

I have been on the Mississippi river and connected with its improvement, I may say, since the inception of the first comprehensive plan for the general and continuous regulation of its navigation, and have seen the gradual evolution of great results from small beginnings. In 1878 we had small mattresses protecting small portions of important harbors; to-day sub-aqueous revetments, almost too large to be called mattresses, and paved slopes reach for miles through long reaches of river that help to control its flow and provide a protection against the destructive action of the current at important levee crossings, and other points, where cut-offs threaten, thus training the river as it should go, and preventing abnormal changes in regimen.

I have seen the levees grow from a ragged, disconnected chain of mounds, badly constructed and designed,* to a splendid system needing but the finishing touches to give absolute protection and uninterrupted trade to the millions dwelling behind it.

I have seen a fleet of the largest, most powerful and most effective hydraulic dredges in the world, the wonder and admiration of engineers of other nations, designed and put to work on the crossings of the river, keeping them open for low-water navigation, and I realize that these great results, this evolution, has not been brought about by chance, but by the untiring energy and ability of our statesmen, Congressmen and Senators, the splendid engineering ability of the Mississippi River Commission and the comprehensive united efforts of our people, those of the valley and all those of the western waterways who have met from time to time to further our great cause.

As an engineer I believe in the levee system as the true and effectual means of controlling the floods of this great river. The day will come when the greatest floods will pass to the sea, "unknell'd, uncoffin'd and unknown." In other words, 1882 and '97 will be but faint, dim recollections of the past, of conditions that used to be, but can be no more. High water will be a matter of little interest to the riparian owner, the protection against overflow will be so perfect.

I believe in the continuation of the revetment of caving banks, thus preventing scour and extensive bar formation, and I believe in continuing the use of the dredge during low water, until such perfect stability of bank by revetments has proscribed its utility.

In spite of the much condemned tendency toward combinations, it is only by continuing to combine and work with all our energy and heart that we will obtain the amelioration of the industrial and commercial institutions of this great valley. Freight rates commensurate with those on the great East and West railroad systems of the country will be obtained and safety and prosperity reign throughout the Delta.

[The foregoing article has been taken in part from papers written by the author and published at different times in the engineering journals of this country, in the Transaction of the American Society of Civil Engineers, and the official reports of the War Department.]

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* Owing to lack of sufficient funds.

T. G. Dabney

SOME GENERAL REFLECTIONS ON THE LEVEE PROBLEM

BY MAJ. T. G. DABNEY,
CHIEF ENGINEER OF THE YAZOO MISSISSIPPI DELTA LEVEE DISTRICT

The work of building a system of levees along the banks of the Mississippi river, for the protection of its alluvial plain from annual overflow, is, in its history, entirely unique among great engineering enterprises, in one important particular.

When any great work involving engineering skill is projected, it is customary before entering upon its practical execution, to ascertain three vital features of the project: (1) is it practicable of accomplishment? (2) what will be the cost? and (3) will the results justify the expenditure?

The engineer first ascertains these three things; he determines in advance just what is to be done, so far as the circumstances of the case will admit, what will be the cost, and what will be accomplished by it in beneficial results.

The methods of levee building on the Mississippi river, from the inception of the work, and throughout its general history, have been the exact opposites of the above-described process in every particular.

These peculiar features of the work of levee building as an engineering problem are due to the mode of birth and development of the system.

The first man who built a levee, or fragment of levee, on the bank of the Mississippi river, had no thought of any "levee system," but merely cast up a small "potato ridge" on the highest part of the river bank, to satisfy his immediate individual needs, very much as the primitive savage erected the first human edifice in the form of a bark shed, perhaps, to shelter himself from the rain.

As levee building was extended by the joining of the efforts of one neighbor to those of others for their mutual advantage, and neighborhoods became involved in the enterprise, there was probably no thought of any far reaching and enduring purpose to grow out of their primitive operations.

Even after levee protection had extended into parish, county, and State organizations, their operations were characterized by faulty locations and crude methods of construction, with no aspirations beyond temporary expedients for immediate effects, the interests at first to be subserved being comparatively small and the cost of even partial protection being relatively great. In fact, the development of levee building in a general way kept pace with the development of the protected regions of country; and to the insufficiency of available resources at any given period of the progressive stages of the work, was due the necessity of pursuing a temporizing policy at all stages.

One result of the causes above set forth has been an aggregated expenditure greatly in excess of what would have been required to construct—de novo—a perfected system of levees throughout the alluvial valley.

Another evil consequence of former imperfect methods in the location and construction of existing levee lines, which has unfortunately projected itself into the levee problem of the present and future, arises from the fact that, to a large extent, old and imperfect levees necessarily form the nucleus upon which the present system is builded.

From the early times of levee building, as the high water plane progressively rose to higher elevations from the extension of the lines of levee, additional strength and height was attained by enlargement upon pre-existing levees; and new locations, where necessary, were made on the least expensive lines compatible with the then present, and immediate future security—due, primarily, to restricted means as well as to a want of knowledge and comprehension of the dignity of the levee problem in its entirety.

A NEW ERA

A period about a dozen years ago may be regarded as marking a new era in levee building. About that time, and subsequently, a strong impetus was given to the work by the interest in the subject shown by the Federal Government, coupled with the large extent of material aid contributed in the form of Congressional appropriations.

It may be here remarked that the large share of such appropriations that has been applied to the levee feature of Mississippi river improvement is directly due to the sympathy and liberality of the Mississippi River Commission, as that controlling authority could readily have found pretexts, under the acts of appropriation, for withholding any part of the money from application to the levees, or of restricting the sums so applied to much smaller amounts.

It may be further remarked in this connection that a probable incentive to this liberality is the fact that money expended in levee work was not attended by any of the uncertainties that attached to expenditures in the other experimental fields of river improvement, but every dollar so applied resulted in certain and palpable benefit of a most valuable sort.

MORE SCIENTIFIC METHODS

About the period above mentioned was first inaugurated an effort to apply a more scientific system to the location and construction of levees in the place of the crude and temporizing methods of the past, the adherence to which to so late a period was the result of restricted means rather than a lack of appreciation of the advantages of improvement in this field, by the levee engineers at least. And even now, after the fullest development in such improvement that is compatible with available resources, we fall short of building ideal levees, because the cost would be too great to be considered.

CREDIT FOR IMPROVEMENT

It may be here remarked that while the levee interests are deeply indebted to the several very able and conscientious members of the United States Engineer Corps who have administered the Government's share in levee building, between whom and the local engineers have always subsisted cordial relations, yet it is unfair to assign to those gentlemen, as has been done in some quarters, the entire credit for the improvement above alluded to, and which they would not claim for themselves, such advancement in methods being rather the consequence of increased resources than of the injection of new ideas.

When the United States engineers first came into this field, it may be said without any disparagement to them, they came upon ground that was new to them, and were naturally and of necessity dependent upon the local engineers of long experience in levee work for their earlier information on the subject.

As a matter of fact, the Levee Board of the upper Yazoo District was the pioneer in the improvement of levee location and construction; and even at the present time, the standards in levee building are higher in this District than elsewhere on the Mississippi river.

It may be pertinent to quote here a passage from a report made by the writer in 1895:

"As a consequence of the combination of insufficient present resources and varying flood conditions, the levee systems have grown up as patchwork, which effect is heightened by recent progress in better methods of levee construction, great advancement having been made in this direction during the past dozen years, in consequence of greater demands on the resisting powers of levees and a more determined effort than ever before made to successfully control the floods of the Mississippi river.

"Much of the improvement of the methods of levee building is due also to the growing experience of engineers and a more serious purpose to study the subject closely and master its intricacies.

"Indeed, prior to about the year 1884 lack of means so dominated in levee matters that very unscientific methods of construction and location were necessarily resorted to, with the inevitable result of uneconomical expenditure of money, and levees that gave way under the pressure of every high water. With the infusion of government funds, and increased means from local sources, much more thorough methods of construction have been introduced, and we now build levees to stand high water without breaking."

Neither should the announcement that none of the levees built by the United States have broken in recent floods, be assumed to mean especial superiority for those levees; since it may be said with equal truth that none of those were broken that were built in recent years by the Levee Boards.

Crevasses occurred only in very old and imperfect levees.

In support of the above statement, it may be said further that no crevasse has occurred in any levee built under the present administration of the upper Yazoo District, that is, since 1884, with a single exception. This exception was a crevasse in 1891, with a comparatively low flood and under a moderate strain, that occurred in a levee built by the United States and the Levee Board jointly, and concerning which there was conclusive evidence that it was the work of human hands instead of natural causes.

IMPERFECTIONS IN OLD LEVEES

The imperfections of the levees that were built in former years, that have come down as legacies to plague the engineers of the present time, were due to several causes:

(1) From the temporary character of the work, less importance was attached to the methods employed and less care bestowed than at present.

(2) Partly from lack of means and partly from the above-mentioned cause, no pains were taken to prepare the foundation of new structures. Numerous large stumps, and even trunks of trees, were covered up, and in soft depressions that had to be crossed foundations were often made of such perishable matter as logs and tree tops.

(The policy of grubbing out all stumps from the foundations of levees was first inaugurated in 1886 by the Levee Board of the upper Yazoo District. Other Levee Boards then looked upon this as an extravagant use of funds.)

(3) From lack of appreciation of the dignity and importance of levees the engineering supervision was very insufficient, the rule being that contractors were allowed to execute their contracts with no inspector present to see the manner of its performance, which led to a great deal of careless, not to say fraudulent, work.

And (4) the low appreciation in which levees were generally held, led to entire neglect and general abuse of them at all times except in the presence of high water dangers, a brief period occurring at long intervals of time. One effect of such neglect was that forest trees were permitted to grow to large size on the levees, in many places rendering them undistinguishable from the adjacent forest, by which the embankments were filled with great masses of roots, which, with buried stumps and logs, rotted after a lapse of years and became elements of great weakness and defection. The rapid growth of all vegetation in this rich soil and humid climate, with the corresponding rapid decay, contributed greatly to this result.

Among the difficult tasks of recent levee engineering has been that of detecting and removing from old levees these concealed sources of defection, where the old levees have been incorporated into the present system.

DOUBTS OF EFFICIENCY

In view of the foregoing it is not surprising that the ultimate efficiency of levees, as an agent for the protection of the Mississippi river alluvial lands, has been held in doubt and disparagements by many persons who were unfamiliar with all the facts and circumstances of the case.

I believe it may be said with confidence that no engineer who is at all conversant with the subject entertains such doubts, or regards the problem otherwise than as a matter of dollars and cents. In other words, the problem of levee protection resolves itself into the simple aphorism: enough dirt, properly bestowed, in the right place.

NEW CONDITIONS

In the great flood of 1897, when very extensive changes had been made, since the last preceding high water, in those conditions that influence the flood regimen of the river, and when vastly greater changes had been made in such conditions since the last flood that approached this one in volume and duration, as a consequence there were many miles of levees that were subjected to a strain very much in excess of what they were built to resist. Instead of having a margin of safety above the flood plane, the opposing flood had a margin of danger above the top of the levee, and was only prevented from running over by robbing the levee itself to obtain material to be piled up on top before the miles of advancing water. Thus, not only were the levees subjected to a much greater strain than they were designed to meet, but at the same time were materially weakened by robbing the slope to increase the height.

It would seem to be creditable to the efficiency of the levees of the upper Yazoo District, that on fifty miles of their extent whereon the water attained an elevation of a few tenths to three feet

above the top of the levee, under a prolonged strain only one crevasse occurred, and that in a levee originally built over forty years ago, and containing inherent defects from its original mode of construction.

BASIC FACTORS

At the present juncture, those who are concerned in the levee problem are confronted by two main factors: (1) the determining of ultimate grade lines for levees to hold maximum floods when entirely confined to the channel of the river; and (2) providing the means to build up to these grades.

In considering the first question presented above, the following quotation is taken from a report by the writer made in 1895:

"Since the beginning of organized efforts to protect portions of the Mississippi delta from overflow, the question of proper grade lines for levees has been the one perplexing and insolvable feature of the problem. The difficulty has been due to the infinitely varied conditions under which different floods have come. The several large tributaries to the Mississippi, with their varying volumes, at different periods, have constituted one important source of variation in flood conditions.

"But the most potent cause of variability has been in the volume of water escaping from the channel, differing at different periods from the progress of local levee building, or, per centra, from the escape through broken levees.

"The task that each levee engineer has set for himself has been to meet the immediate and visible needs of the situation then existing, always with insufficient means to do more than keep his grade lines above the highest local water marks—often with means insufficient to do even that—in a constant struggle to advance his grades to meet advancing flood heights and leave a reasonable margin of safety for unforseen contingencies.

"There have never been at his command either present resources or present information upon which to base an effort to reach the final goal—to build levees high enough and strong enough to resist the highest water that might ever be expected to tax their strength and endurance.

"Indeed, such a standard of levees, if it had been adopted prematurely, would have proven an unwise expenditure of money, resulting in a much greater height and strength of levees than the then present needs demanded, much of which, on temporary locations, would have been sacrificed to caving banks.

"In the nature of the problem, then, the question of standards in levee building must have been tentative and progressive."

DISCOURAGEMENT AMONG THE PEOPLE

The ever increasing elevation of the floods, with advancing restriction of the flood volume by the extension of new lines of levees, has presented itself to the contemplation of the "lay" mind with discouraging effect. This was markedly the case in 1897, when much greater changes had been wrought in local flood conditions than at any other period in the history of levee building. To the average citizen who did not understand the specific causes that produced special and extraordinary developments in flood elevation, and could not see the limitations upon those causes, there seemed to be no stopping place for the upward movement, within any practicable bounds.

Take, for example, the front of the White River Basin. Here, levees had been maintained for a long period of years on the eastern side of the Mississippi river opposite to that front, while on the western side the flood water had escaped unrestrained into the White river swamps. The flood plane normal to these conditions had a depression along the middle part of that front, some five or six feet below that normal to a confined flood volume.

The flood of 1897 found this part of the river leveed on both sides, for the first time perhaps in its history. The immediate effect was to fill up the depression and establish a new flood plane in accordance with the new conditions in their relation to the gauge at Helena, Ark., at the head of the White River Basin.

Upon this new flood plane would have been superposed the additional height at Helena, but that the numerous breaks in the levees along the White River Basin before the culmination of the flood permitted the excess of water to escape.

While these phenomenal developments were bewildering and appalling to citizens immediately concerned, the cause and sequence, and probable limitation of the upward movement, is apparent to the discriminating engineer. Like conditions will be set up along the St. Francis front when that

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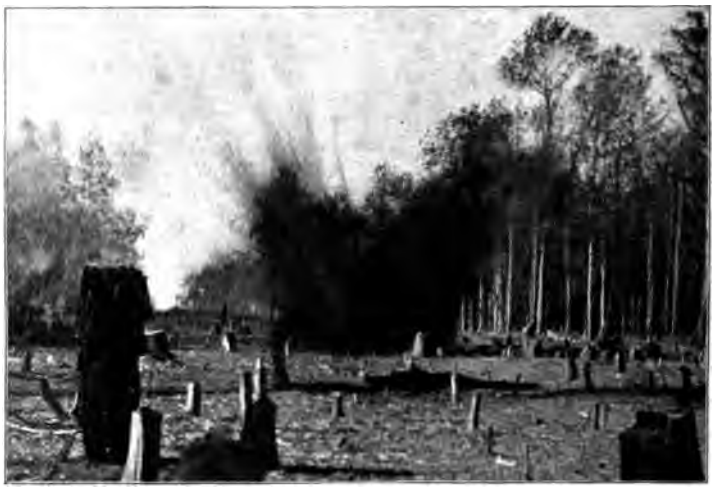

BLOWING OUT THE RIGHT OF WAY.

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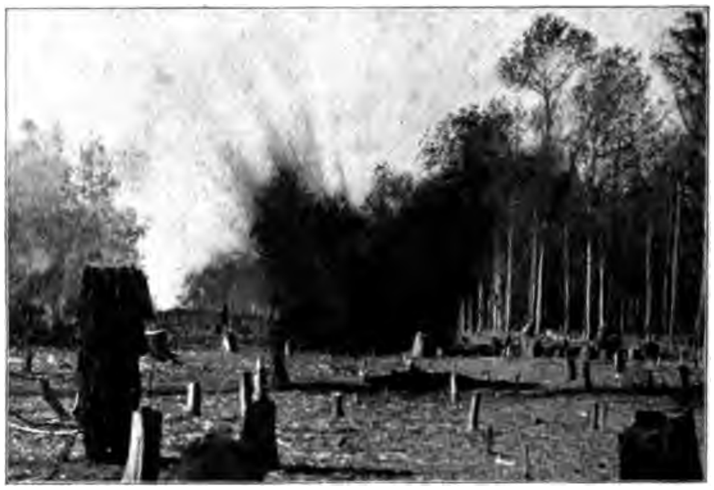

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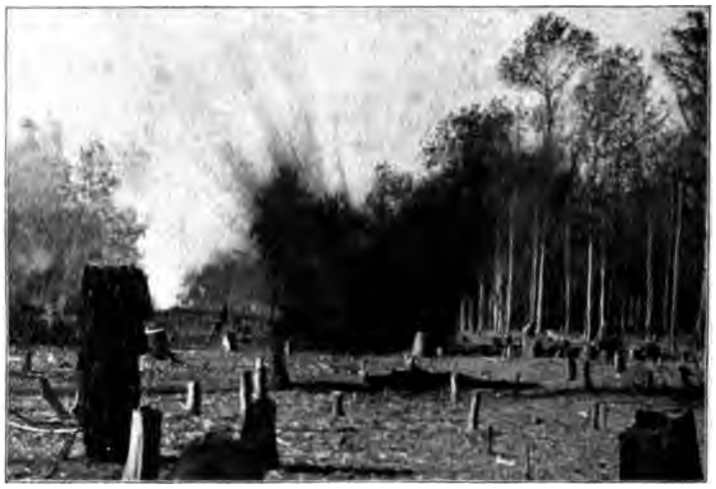

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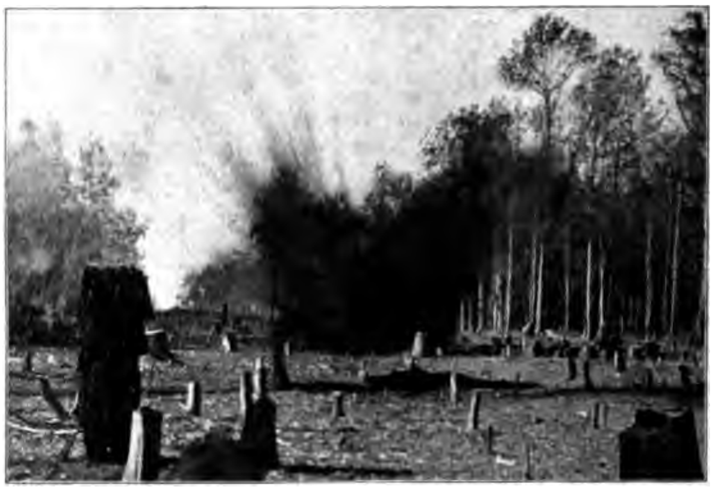

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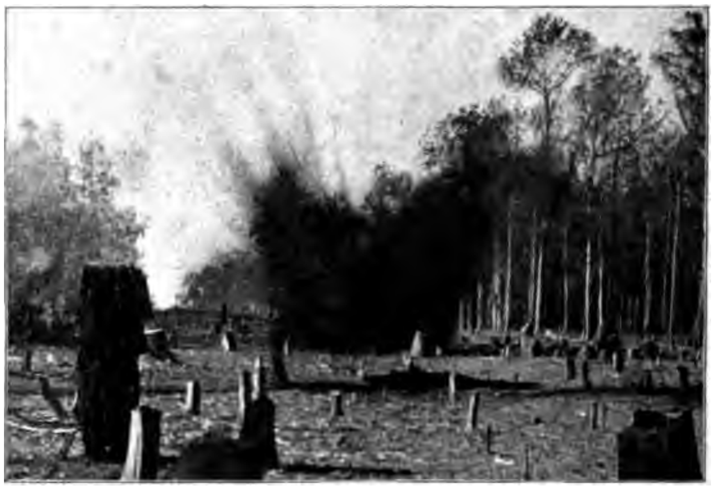

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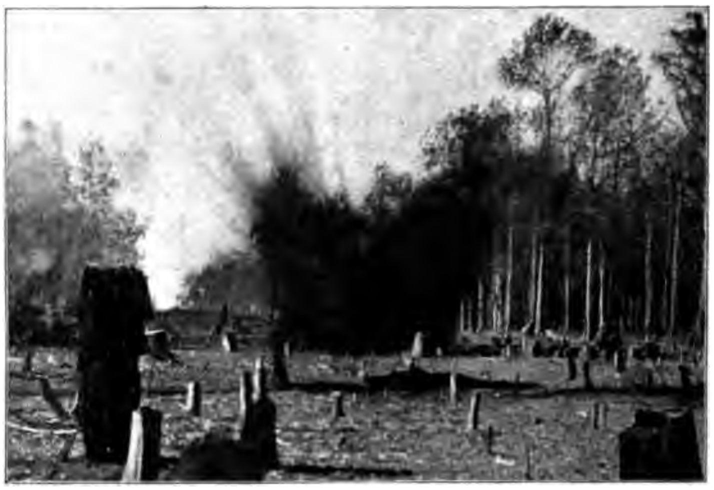

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basin has been completely leveed, with the maximum effects probably along its middle portion.

The flood of 1897 was epoch making in the light it has thrown upon the question of ultimate grades. While it cannot now be said with precision how high the ultimate flood elevation will reach at any given point, yet the margin of uncertainty may be said to have been reduced to workable limits, so that engineers can compute with considerable confidence the amount of final cost necessary to a perfected levee system from Cairo to the Gulf.

This amount has been estimated by the Mississippi River Commission at $20,000,000, which estimate is generally concurred in by levee engineers.

REVENUE FOR ULTIMATE COMPLETION

This brings up the question as to the source or sources from which this money is to come; and here another quotation from the writer's report of 1895 may not be inappropriate, which is as follows:

"It is probably fortunate for the interests of levee protection that it could not be foreseen a dozen years ago what increasing demands would arise to build levees that would certainly give security from overflow, and to meet increasing flood elevations, due to increasing progress in levee extension. A complete fore-knowledge of the enormous expenditures involved, instead of a gradual realization, would probably have discouraged all attempts at beginning; whereas good enough has already been accomplished to justify the expenditure made. And complete and permanent security from overflow is now within the grasp of the people, provided there is no relaxation in their efforts until it is accomplished."

THE UNITED STATES GOVERNMENT

It is the hope of many that the United States will assume entire control of the whole matter of levee building, and furnish all the funds necessary for completing a general system of levee protection.

This is "a consummation devoutly to be wished," certainly from a financial standpoint, as it would afford vast relief to the overburdened taxpayers, who have already expended so much money and effort in this herculean enterprise.

If, however, this hope cannot be fully realized in the immediate future, it may be expedient to try for "half a loaf" instead, to begin with, which vantage ground would greatly aid in getting the other half later.

When Mr. Benjamin Harrison was President of the United States, although his attitude was somewhat hostile towards the expenditure of Government money on the levees, he was reported in the newspapers to have expressed himself in an interview with some levee advocates as being willing for the United States to pay one-half the necessary cost of levee building, while the local interests should pay the other half.

This appears to have been in recognition of a community of interests in the levees as between the United States and the land owners in the region of overflow, the former being concerned in their function as an aid to navigation, and the latter in protection for their lands.

Other representatives of the Government have more recently revived this suggestion as a basis for the settlement of this question.

In the event of failure to realize the larger aspiration at this juncture, if the above principle were recognized, and so settled, it would be a great and valuable gain for the levee interests, as definitely committing the United States to the assumption of an obligation in the premises, whereas the aid heretofore extended to levee work by the Government has been in the nature of gratuity, the further extension of which the Congress is at liberty to withhold at any time.

In this connection another consideration may be entitled to weight, to-wit: if the Government should admit the obligation to pay one-half the cost of a perfected levee system, the fact that the Levee Boards of the larger districts have already contributed an aggregate amount greatly in excess of the Government contributions, ought to entitle them to credit for such excess in future distributions of Government funds.

COST OF MAINTENANCE

The question of the cost of maintenance of a levee system after being perfected has been a subject of much inquiry by the Senate Committee charged with the investigation of the levee question. The cost of simple maintenance, other than that of renewals of portions of the levee lines attacked by caving banks, would be very small, comparatively speaking. The only very considerable item of cost of maintenance would be that of re-

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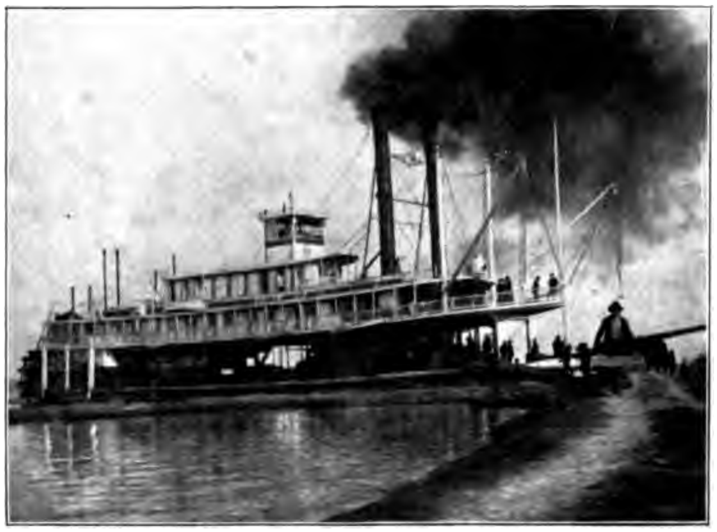
ɔMMENCING LEVEE BUILDING ON THE RIGHT OF WAY.

HIGH WATER SCENE, PITCHER'S POINT.



HIGH WATER—STEAMBOAT LYING AT LEVEE.

newing parts of the levees that shall have caved into the river, assuming that there would be no crevasses from high water pressure.

The expressions of various engineers, civil and military, who are more or less conversant with the subject, as published in the report of the Senate Sub-Committee who made the investigation, indicates that the average annual loss of levees by caving ranges from 2 to 5 per cent, 2 1-2 per cent being about the average, of the linear extent of the levee lines.

I believe the questions asked the several witnesses, on this point, by the investigating committee that elicited the above expressions, gave the deponents but little opportunity for reflection before giving their estimates or opinions.

In reflecting upon this question I am impressed by the following considerations: The extent of the levee lines on both sides of the river, between the mouth of the Arkansas and the mouth of the Red river, is approximately 540 miles. Along this extent of river the steep slopes, large volume of flood water, and yielding character of bank formation, give a maximum rate of bank caving greatly exceeding the rate both above and below that extent of river. The extent of levee lines above and below the above named limits, where the rate of caving is minimized by the flat slope below, and lesser volume above, is nearly twice as great as that along the region of maximum caving.

Under the writer's observation the loss by caving, or rather the extent of new levee necessitated by caving banks, has been under seven per cent during fifteen years, or less than one-half of one per cent per year, in the upper Yazoo District. It may be presumed that this represents something like the general rate of annual loss above the Arkansas river and below Red river; and that, under conditions of less security than would obtain in a perfected system of levees.

My deduction is, that an average of one per cent a year would represent fully the average annual loss in linear extent of all the levee lines along the river with a perfected system of levees.

ELEVATION OF THE RIVER BED

The question as to whether leveeing the Mississippi river has a tendency to elevate its bed, had been a bugbear in the minds of many people. Most persons who for any reason are antagonistic to levees, have no scruple in making the bold assertion that leveeing the river has that effect, and that there will be no limit to the height to which levees must be built to be kept above the ever rising flood plane. Many others who are not antagonistic to the levee interests have imbibed that notion also.

When asked for evidence to support such assertion, none can be given; or for reasons for such belief they have none, except perhaps of a fantastic sort. And the notion is widely prevalent.

A good many years ago, in some unaccountable manner, the story became current that the River Po, in Italy, afforded an example wherein its bed had risen in consequence of being leveed for a long period, until it had reached an elevation above the adjacent country. It is difficult to conceive how such a story could have got abroad, having not the slightest foundation in fact. And yet it was seized upon with avidity and passed from mouth to mouth with ready acceptance.

A thorough investigation of the River Po story revealed the fact that during a period of two centuries of its leveed history, in some places in the upper reaches of this river, the bed had risen about one foot, due to the presence of gravel, that could not be easily moved by the current. In other places the examination showed a depression in the bed of the stream.

A similar story has been current regarding the Yellow river in China. Our information about the characteristics of the China river is too meager to warrant us in drawing an analogy between that stream and the Mississippi river. We do know, however, that the Yellow river passes for a long distance through a low flat plain, and that it has suddenly changed its channel of discharge into the ocean to a point several hundred miles from its former mouth; which indicates a very marked dissimilarity between that stream and the Mississippi.

The River Commission has given very careful study to this question, in relation to the Mississippi river.

Among other methods of investigation, one was to cause elaborate soundings to be made over an extent of four hundred miles of leveed river channel, which were repeated over the same lines after an interval of fourteen years. It was found difficult to arrive at a conclusive decision from a comparison of these two sets of soundings, owing to the mobile and shifting character of the materials composing the river bed. Where a shoal would be found on a given line of soundings at one period, a pool would appear at another time along the same line, and vice versa. But so accurate and conservative an engineer as General C. B. Comstock, after a careful examination of all the data afforded by these soundings, stated that there was no evidence that the bed of the river had risen during the period covered by his investigations. While it seems impossible to obtain positive and direct evidence on this question except after a long lapse of time, there are some facts, a good deal of indirect and negative evidence, and the deductions from a priori reasoning, all tending to confirm the above conclusion.

ARGUMENTS AGAINST THE FILLING-UP THEORY

Some of the arguments opposed to the filling-up assumption are the following: (1) We have the concrete fact, that the River Po, presenting phenomena somewhat similar to the case under discussion, has not appreciably silted up its bed during a period of two hundred years.

(2) The Mississippi river, between New Madrid, Mo., and Helena, Ark., has for a very long time been depleted by the diversion of a large part of its flood volume from the main channel through the St. Francis river, returning through that stream to the present river near Helena. We ought logically to find that this section of the main channel has suffered deterioration by the dissipation of part of the energy of its flood volume. And that is what we do find; for the low water plane in this part of the river is shown to be several feet above the normal for an undivided volume, which could only have resulted from silting up the bed, in obedience to the law that adjusts the capacity of a channel to the volume it has to carry.

(3) In the year 1894, the low water plane from Cairo down was generally much lower than any former records show, and the depression was most conspicuous where the greatest influence had been exercised by levees, while the volume that passed Cairo, and the lower tributaries, was not less than in other low water seasons.

(4) Observations show that where important crevasses in the levees have remained open for a series of years, through which a large portion of the flood volume has escaped, the river channel immediately below such crevasses has suffered deterioration from silting up, as a consequence of diminished energy of the current.

(5) We know that the materials that compose the bottom and sides of the river bed yield readily to the scouring action of the current wherever it is directed against them. Also that an increased volume of water in such a bed should demand and create for itself an increase of channel capacity, which should logically be by erosion on both the sides and bottom; and this is in accordance with the facts wherever observed.

THEORETIC VIEW

In theorizing in a general way upon this rather obscure problem, the following reflections suggest themselves, and are here given for what they may be worth: We know that throughout the history of the Mississippi river, there has been a general filling up of its alluvial plain and of the river bed along with it, by material brought down from the hill country above. But the great bulk of these results now displayed to our observation, were in consequence of geological agencies covering very long periods of time, and long anterior to the present era.

The conditions as we now find them, indicate that the alluvial agencies have very nearly reached a state of equilibrium, as between the quantity of alluvial matter brought into the head of the basin and the quantity carried out at its mouth; and the further progress of the filling up movement is exceedingly slow. We see rapid mutations along the banks of the river, in the immediate vicinity of its channel, as well as within the channel itself, which make the impression of a vast capacity of the river to build up. But the material that we see so handled by the river is derived from a previous tearing down of its own banks and bed, and is deposited in compensation for a previous displacement of other material. The river under natural conditions enters the alluvial basin with a certain quantity of sedimentary matter, held in suspension or rolled along its bed. It departs through its several mouths and carries into the Gulf of Mexico a certain quantity of such matter. The quantity carried out into the Gulf, plus the quantity deposited over the alluvial plain between its head and foot must exactly equal that brought in from above. But the quantity spread over the alluvial plain away from the immediate vicinity of the river, is relatively speaking, exceedingly small—I mean when the escape of water is unrestrained by levees. The river water when in a turbulent condition, at the top of the flood volume, contains one part of sediment to twelve or fifteen hundred parts of water, mostly derived from local sources, and most of which is locally precipitated by the escaping water, that is, on or near the river banks where it is again yielded up to the channel volume by caving or erosion. The escaping flood water carries away from the river, over its banks, but a small relative quantity of sediment, and that mainly pursues the bayou channels. Some deposit is left along the banks of the bayous where they are over topped by the flood, which however is quite unusual under natural conditions of overflow, in the existing stage of alluvial formativeness. Most of this burden of fine silt that is borne away from the vicinity of the main channel, is carried on through the subsidiary channels and re-enters the river below. The overflow water that covers the intervening plain, outside of the bayou channels and their associated ridges has little or no motion, and its quantity of deposit is inconsiderable.

Now, where the escape of flood water from the channel is prevented by levees, the suggestion is that the increased volume of water within the channel so far increases the energy of movement and consequent carrying capacity, as to enable the river not only to convey this small excess of material into the Gulf, but also to enlarge its channel by scouring the bed, as well as by eroding the banks, so as to accommodate the increased volume which has been imposed upon it.

If this view is correct, the apprehension that the Mississippi river will silt up its bed in consequence of being leveed, is manifestly unfounded.

MOONLIGHT ON THE MISSISSIPPI.

Wm Starling

RIVER BASINS AND THE LEVEES WHICH PROTECT THEM

BY MAJOR WILLIAM STARLING

Every man who is in the habit of making journeys on the great lines of railway has probably observed some of the phenomena of alluvial valleys, for these are selected by the engineers as a bed already partially graded by nature for their roadways. In ascending a mountain range, instead of excavating, escarping and tunneling a road for ourselves, we have only to find in the lowlands a river, the general direction of whose course corresponds, as nearly as may be to the route sought by us, and then following the stream upward toward one of its sources. In this manner we are conducted by an ascent, easy and gentle at first, afterwards steeper and steeper, to the dividing ridge, whence, by a reversal of the former process, we gradually descend to the plains on the other side. Those whose faculties are not buried in sleep or benumbed by a dull novel will have observed that the river, after running between iron-bound rocks, expands occasionally into broad and fertile "bottoms," becoming wider, longer and more continuous as we descend. These bottoms are bounded on either side by the highlands which have served to limit the excursions of the river, and this latter wanders through the valley, skirting the base of the hills, now on this side, now on that, pursuing a tortuous course through the bed which it has made for itself; for the bottoms are the work of the river—are composed of sediment brought down in time of flood, and spread far and wide as the swollen stream overflowed its narrow banks. Being the product of the stream, they are composed of pulverized material, free, for the most part, of stones and heavy fragments. Being formed by overflow, they can never rise above the level of the stream in flood; indeed, can never attain the height of extreme floods, and must always be liable to overflow in great freshets.

Thus the valley, continuous it may be in itself, is divided into a series of subordinate basins, each bounded by the river on the one hand and the hills on the other, and terminated, above and below, by the close approach of the highlands to the stream.

What occurs to creeks and mountain streams on the small scale, occurs also to the greatest rivers. The history of the Ohio and Mississippi is a good deal the same as the history of the rivulets from which they originate, multiplied a thousand-fold. The most insignificant meadow-brook is a Mississippi in miniature; and the student of river engineering has often spent most profitable hours in contemplating, on a scale which may be easily embraced by the eye and the understanding, phenomena which embarrass and bewilder him when presented with magnificence and complexity which attend the operations of a mighty river.

In mountainous countries creek-bottoms are of great importance on account of their unexampled fertility, all the more, as distinguished from the stony and arid tracts which surround them. Offering no impediments to the plough, being nearly level, and having excellent drainage, they possess unusual advantages for cultivation. They have but one drawback. A flood of unusual height may submerge them, and the farmer may loose his labor partially or wholly—partially, if the flood be not very great, or occur so early that the crop may be replanted; wholly, under very unfavorable circumstances, for not only may the overflow occur late in the season, when the greatest outlay has been incurred, and the owner is about to reap his return, but the flood may be of such magnitude as to sweep away the accumulated labor of former years—fences, stables, even dwellings, and may go so far as to cause loss of life itself.

Overflows occur, of course, because the ordinary channel of the stream is not sufficient to contain the unusual quantity of water poured forth at the height of the flood; neither can it ever become sufficient under the operation of purely natural causes. The stream has built for itself a bed, distributing its sedimentary matter beyond its banks, and preserving for itself a channel suited to its ordinary wants. Great floods occur too seldom, and endure too short a time to exercise a marked influence in enlarging the channel by their excavating power.

So valuable are the bottom lands that they are almost always cultivated in spite of the danger of overflow. It is natural, however, that means should be sought to protect them from this calamity. Now, to give flood plains immunity from inundation, only one means exists; that is, to make the river-channel large enough to hold all the water, ordinary or extraordinary, that can possibly be poured into it. To enlarge the channel we must adopt one of two alternatives—dig its bottom deeper or wider, or build its banks higher. The latter being by far the easier and cheaper process, is the expedient commonly adopted; the more, that it does not exclude the former, nor is at all antagonistic to it, but, on the contrary, facilitates it and co-operates with it.

Thus, the system of artificial embankments or levees, as the French settlers called them, naturally suggests itself wherever there are alluvial bottoms or flood plains of considerable extent. It is a method which cannot generally be used with advantage on a small scale for several reasons. When streams are ordinarily inconsiderable, with high freshets and the flood plains narrow, levees are expensive and out of proportion to the benefit to be derived. In narrow valleys the line would have to be very long to protect an insignificant area. Not only so, but being hemmed in between the hills on one side and the levees on the other, there would be no drainage, and the injury from rain and surface water would perhaps be greater than from overflow.

The method of protection by means of levees is then peculiarly applicable in the case of large rivers with very wide valleys, and under these circumstances it has long been successfully practiced. The question of drainage, however, is still a serious one. The great basins are usually heavily overgrown with timber. Evaporation is consequently very slow, and the accumulation of rain and surface water is very great, especially in the lower part of the protected area. For it must be remembered that bottom lands are by no means level in the strict sense of the word, but follow the fall of the flood line—that is, they slope toward the sea. Therefore, if drainage be free, all the water which collects in an enclosed area will accumulate at the lower end. This aggregation will not only occupy a great space which might profitably be reclaimed, but will greatly impede the free flow of drainage waters from the upper part of the area. Consequently, in a strictly enclosed basin, it is found necessary to provide pumps or equivalent means of getting rid of the surplus waters. Culverts may be used, but, of course, are available only after the flood waters have begun to recede.

In the case of a very large basin it may be found the best plan to leave the tower part thereof entirely open. This portion will thus be subject to overflow, but only to a limited extent. For the flood waters, entering at the very foot of the basin—that is, at the lowest possible elevation—cannot mount higher than the level of that part of the stream. As the flood plain has a considerable slope, the upper part will be perfectly dry. For instance, the fall of the flood plain of the Mississippi river from Memphis to Vicksburg is about two-thirds of a foot to the mile. The average height of the greatest floods above the surface of this flood plain is perhaps eight feet. Suppose a system of levees, complete in its upper part, to terminate abruptly at any given point. Then at that point the land will be overflowed eight feet. Twelve miles above the land will be just a wash. Twenty-four miles above the land will be eight feet out of water.

The course which has been prescribed for theoretical reasons has been made compulsory in the case of the Mississippi by the intervention of tributaries. Every basin of considerable size must of necessity have an auxiliary stream or streams to drain it into the main river. Usually, from the nature of the case, the drainage is concentrated into one stream. The borders of the main river are high, for they receive the bulk of the deposit, as fresh quantities of loaded water are continually arriving, which drop the greater portion of their burden as soon as they become dispersed, and afterwards less and less as the water becomes more stagnant and clearer. Thus, small streams, tributary to the main river, or inlet bayous as they are called, are rare. The course of drainage almost always is from the high alluvial ridge on the bank of the river to the low lands in the interior, and eventually to the main tributary which skirts the hills, and at the foot of its basin discharges into the Mississippi. These tributaries are usually of such magnitude that it would be well nigh impossible to levee them. They receive, beside the drainage of the alluvial basin proper, large accessions from minor streams which descend from the hills, so that even if they could be leveed the volume of water thus imprisoned behind the levee would be portentiously great, too great to be pumped out or discharged in any reasonable time through a culvert, so their mouths have to be left open perforce. The basins narrow toward the lower end, so that the quantity of land damaged is still further reduced.

The valley of the Mississippi, like all others, is divided into a number of subordinate basins by the approach of the hills on either side. Some of these basins are very small, others are of enormous extent. Each is in a great measure independent of the others, so that the task of protection from overflow is much simplified and rendered more practicable, as it does not necessarily require a vast and simultaneous organized effort, or even a continuous system, but may be effected in detail, according to the needs and abilities of separate sections.

The small basins do not afford the best field for the application of the levee system for reasons already given, and for the additional reason that in them backwater from the mouth of the tributary is destructive out of proportion. For instance, if the influence of backwater is more or less detrimental 15 miles above the mouth of the tributary, and the basin be only 20 miles long, then three-fourths of it will be more or less liable to injury in time of flood. But if the basin be 150 miles long, then only one-tenth will suffer.

It is to the great basins, consequently, that we must look for examples of successful protection by levees. Below Cairo the Mississippi has four such basins, drained respectively by the Saint Francis, the Yazoo, the Tensas and the Atchafalaya rivers and their tributaries. The last three have been wholly or partially leveed for many years. The nearest approximation to a complete system has been made on the Yazoo front.

The Yazoo basin has every advantage that the engineer could ask for a fair trial of the levee system. It begins a short distance below Memphis and extends to a point a little above Vicksburg. At each of these localities the highlands actually abut upon the Mississippi river, thus completely isolating the basin, and affording a secure support for the ends of the line of levees. The front of the basin, measured according to the sinuosities of the Mississippi, is about three hundred and fifty miles long. In a straight line the distance is about one hundred and eighty miles. Its shape is lenticular, the Yazoo hills forming one arc and the Mississippi river the other. Its extreme breadth is about sixty miles. There are no "inlet bayous," the drainage being altogether toward the interior, and eventually into the Yazoo river. This, under one name or another, skirts the base of the hills, and empties into the main river just above Vicksburg.

The entire front of the Yazoo basin is closed by a continuous embankment, extending from the uplands below Memphis to within about eight miles of the mouth of the Yazoo. This embankment does not strictly follow the line of the river, but sometimes takes short cuts, so that its length is about three hundred miles. The material of which it is composed is earth entirely. It is usually eight feet wide on top. The height is defined by reference to some great flood, usually the most recent. The angle of inclination of each of the slopes of the embankment, front and back, is fixed by the proportion, three of base to one of altitude, though sometimes the dimensions fall short of these and sometimes they exceed them. In fact, both in height and strength, the levees are somewhat irregular.

The causes of these variations in construction are not usually to be sought in any scientific considerations. They are due, for the most part, to the haphazard manner in which the levees were built. Originally constructed by private enterprise for the reclamation of partial areas, they have been connected, raised, enlarged, repaired, demolished by crevasse and overflow, wiped out of existence by caving into the river and replaced by entirely new lines joined to the old at suitable places, as necessity dictated or financial conditions permitted. The system is a patchwork, in fact, the result of many different periods, organizations and administrations, having diverse views of policy and managed with all possible differences of ability and resources. To enter into a minute history of the levee system would probably be neither interesting nor profitable, except to a professed student of that subject. With reference to the Yazoo front, it may be sufficient to say that the close of the civil war found in existence two "levee districts," as they are called, each containing several counties, and embracing together the whole Yazoo basin. Of these, the upper, or District No. 1, fell into bad hands, in the confusion and misgovernment of the reconstruction period, and eventually lapsed into complete decay, and its levees were suffered to go to ruin. The lower district was then reorganized and rebaptized as the Mississippi levee district, and has maintained a flourishing existence, under one name or the other, for the last twenty-five years. In 1884 the counties not included in this district were incorporated into a new organization called the Yazoo-Mississippi delta levee district, which thus consists substantially of nearly the same territory as old District No. 1, but is to be carefully distinguished from it, as it does not and should not inherit the evil reputation or the unpaid obligation of that corporation.

As at present organized, the levees of the Yazoo front are maintained by two districts, each with its own organization and its own methods of raising revenues. The supreme governing bodies of these districts are called levee boards. They consist of one or more members from each county in the district. They are armed with a good deal of authority, with power to impose taxes up to a certain limit, to condemn lands, and to exercise all functions incidental to the building and maintenance of levees. They elect their own officers and fix their own rates of salaries.

The territory embraced within these districts are mutually dependent on the levees of the other. The lower district would be partially overflowed by breaks in the upper; and certain counties of the upper district lie behind those of the lower, and would be affected by any breaks in the levees of the latter. Attempts have been made to consolidate the whole administration in the hands of one board, but serious obstacles have been found to exist in the different rates and manners of taxation of the two districts, their debts and a diversity of local interests. So far, very little practical inconvenience has been found in the division of territory, the two organizations having worked together very harmoniously.

There is a great diversity in the soils composing the alluvium of the Mississippi valley, and three or four qualities are likely to be encountered in the construction of a single levee—nay, even to be intermingled in the same bank. It is often very difficult to decide which is the prevailing quality, much more to decide in advance, for the guidance of assistant engineers and contractors. In this uncertainty it has very commonly been the practice to build levees by a rough rule, supposed to be safe in the average of soils, of making the base of each slope, front and back, three times the height. The total base of the levee will thus be six times the height, plus the width of the crown, usually eight or ten feet. Levees of these dimensions will generally stand, with water to the very top, even in soils weaker than the average. Neither is it a great waste to give the same proportions to embankments built of stronger material, to wit, of "buckshot" clay, if put up loosely with wheelbarrows and exposed to the pressure of the water while yet "green," for such banks are very porous and apt to leak and slough if of inadequate dimensions. Still another reason for a broad base will be given in the sequel. In the absence, then, of definite reasons to the contrary, levees have usually been built with slopes of three to one.

Where there is great exposure to the action of winds and waves these dimensions are modified, the outer or front slope being made flatter and the inner slope steepened or not, according to circumstances. It has not usually been found good policy to make the back or land slope very steep, for fear of sloughing. After completion the whole work is sodded with Bermuda grass, which puts out lateral runners, taking root at the joints, and thus spreads rapidly, covering the slopes, in a year's time, with a thick mat of sod.

When a water works engineer is called upon to build an embankment for a reservoir, the first thing he looks to is his foundation. Though his dam be never so massive and tight, it avails him nothing unless it rests upon a secure bed. The levee engineer has seldom been able to take the same precautions. In the first place, they are not so obligatory. The water does not usually stand very high against his embankments, nor does it remain there the year round. He has an ample base. Experience had not formerly been understood as indicating the necessity of devoting special attention to foundations. In short, a good bank placed on the natural soil has been thought sufficient. Usually, indeed, the means have not been forthcoming for any refinements of engineering. The urgent demand has been for earth, and more earth, piled higher and higher and yet higher as the system neared completion. The experience of 1897 seemed to teach that the principal danger to be apprehended was that of the actual overtopping of the levees, and of course the principal efforts have been made with a view of avoiding this imminent peril. With the advances in levee building, however, the more perfect confinement of floods and the new constructions on lower ground, caused by the caving of banks, the levees have had to stand a great deal more water than formerly.

To provide an absolutely secure foundation in the variable soil of the Mississippi bottom without incurring enormous and ruinous expense seems almost impracticable. Yet resort may be had to expedients that promise a practical assurance of safety. It has long been customary among levee builders, before commencing the construction of the embankment, to dig a ditch three or four feet deep parallel to the general line of the levee and to fill it with well tamped clay or strong loam. Such a trench is called a "muck ditch." By some etymologists this is supposed to be a corruption of "mock ditch," but I am not aware of any evidence to support the hypothesis. Usually the dimensions given to this feature have been insignificant and its effect correspondingly small. It might, however, be rendered an important safeguard by making it six or eight feet deep and correspondingly wide and paying especial attention to the tamping, thus increasing the length of the route to be traveled by the percolating water, and by giving additional height and weight to the column of mixed earth and water that has to sustain, on the land side, the upward pressure proceeding from the weight of the external water. Given a levee ten feet high, with no muck ditch, and a water-bearing stratum two feet below the surface, we have a pressure of ten feet of water on the outside with only a weight of two feet of earth to offset it. But put a foundation of six additional feet beneath this levee, and we have sixteen feet of water offset by eight of earth, which is much better. Moreover, twelve feet more of frictional resistance have been introduced. Other important auxiliaries are increased width of berme on the outside and a banquette, as it is called, on the inside, this latter being a layer of "made earth" three or four feet deep and twenty or thirty feet wide, intended to give additional security against sloughing and to hold down by its weight the internal crust and keep it from "blowing up."

That an earthen bank should be preserved from deterioration, the first and almost the only requisite is that it shall be made of earth only—that is, that no stumps, roots or other perishable matter should be left in it, or immediately under it, which by its decay should leave cavities or conduits. That it may preserve its "grade"—that is, its proper height relative to high water—occasional repairs will be necessary, especially in situations where it is apt to settle, as in crossing the beds of old water-courses or the like.

A line of levees is, of course, not level from Memphis to Vicksburg, but follows the fall of the river. Now, this fall, or slope, is about a third of a foot to the mile, if taken in the average. Yet he would be a very foolish engineer who should take it for granted that the rate of fall was uniform and should build his levees on that supposition. The river, in fact, is divided into pools and rapids. In the pools the water surface remains nearly level, sometimes for miles, and in the rapids the fall is often as much as three or four times the average.

Levees as they actually exist do not, however, approximate closely to this ideal for reasons already mentioned. It is the constant effort of those in charge of the different districts to bring them, step by step, nearer to perfection, but they are still far from the goal, though well within sight of it. Knowing their systems to be imperfect, it is with anxious hearts that they face great floods, for the chance of disaster is present every day as a possibility or probability as long as the water is near its height, and the period of trial is sometimes lengthened into months.

Arthur Hiden

IMPROVEMENT OF THE LOWER MISSISSIPPI RIVER

BY CAPT. ARTHUR HIDER, ASS'T U. S. ENGINEER

By the Lower Mississippi river is meant that portion of the river between Cairo and the Gulf.

The most suitable method to be adopted for the permanent improvement of the Mississippi river is a problem that has called for the best thought and study of the engineering profession, and, although it has not as yet been satisfactorily solved, still considerable progress has been made.

A vast amount of valuable data has been collected and digested, experiments have been made with different methods and materials, these have been abandoned when not satisfactory for others promising better results and new ones substituted as experience dictated and the magnitude of the undertaking became better understood.

Few persons, except those actually engaged in the work, realize the almost insurmountable difficulties that are to be overcome in a successful and satisfactory solution of the problem.

The stupendous forces developed by the Father of Waters in its course through the Valley, flowing through a bed of alluvium of its own formation from Cairo to the Gulf—a distance of upwards of one thousand miles—the instability of this material; the ease with which the banks are eroded and the bed scoured by the action of the current during high stages, frequently causing a complete change in the position of its channel and rendering nugatory the effects of the works already constructed to improve it; the changes due to rapidly caving banks and cut-offs and the effects of the annual floods combine to render any system of improvement difficult as well as expensive in execution and necessarily requiring large annual expenditures for its maintenance and preservation.

In considering any plan of improvement it is evident that it should be so designed as to apply to what may be considered two distinct rivers, one at flood or high stages and the other at low water. In the first instance we have a river with a discharge approximating two million cubic feet per second. The width of the river at high water controlled only by the distance between the levees on each side which are generally upwards of a mile apart, and a channel depth of from eighty to one hundred feet, with a velocity of current approximating four miles per hour. During this period new bars are built up or existing ones enlarged or it may be entirely obliterated, vast volumes of sand, a large portion of which is eroded from adjacent banks, are transported and deposited forming new bars or adding to those already existing; these as the river falls to its lowest stages become obstructions to the channel navigation.

At low stages we have a discharge of from one to two hundred thousand cubic feet per second, a much less current velocity and at many points a shallow, narrow stream following a tortuous course between sand bars built up during the preceding floods.

One of the great difficulties experienced in designing any system of channel improvement that shall be permanent and give satisfactory results is due to the fact that at high stages the conditions are altogether different from those existing at low stages. Works constructed in the river bed for contracting the channel and improving low water navigation while accomplishing the desired results, at flood stages are obstacles to the rapid discharge of the water as they restrict the area of the waterway and to that extent are detrimental, as they increase the flood heights.

When it is considered that the oscillation of stage from extreme high to extreme low water at some points is nearly fifty feet, it will be readily seen that in any plan of improvement two entirely different rivers, as it were, are to be considered.

Were it possible to reduce the difference of stage between high and low water to say twenty feet instead of fifty, the problem would be greatly simplified. Under these conditions the river would develop a channel suitable for the approximately more regular discharges, the current velocity would be more nearly constant, the erosion and caving of the banks materially reduced, the channel and thalweg of the stream at low stages as this developed would be subject to comparatively much slighter changes, thus insuring a wide, deep channel at all stages.

Reservoirs located near the head-waters have been advocated as a means of improvement of the lower river, designed so as to restrain part of the flood water and allow its dispersion at lower stages. This plan would no doubt be beneficial and tend to ameliorate to a certain extent the unfavorable conditions existing at low stages, could reservoirs of sufficient capacity be constructed and maintained. The magnitude of an undertaking of this kind, the attendant cost, the danger of dams bursting and the damage that would ensue, and the cost of maintenance, in addition to the value of the land necessary would be so great, that it is doubtful if this plan on a large enough scale to give practical results will ever be undertaken.

So far as the prevention of floods in the lower river is concerned it should be borne in mind that these are generally caused by heavy local rains in the vicinity of the main river or from floods in the tributaries. Reservoirs near the head-waters would have little effect in the lower river on floods, as these are usually produced by floods in the Ohio and its tributaries and the tributaries of the Mississippi river that empty into the river below Cairo.

Outlets have had their advocates, but the opinion of the ablest engineers who have studied and investigated this subject is that the action of outlets affords no permanent relief and they do not recommend their use, as the effect is to bring on a gradual deterioration and shoaling of the channel and for this reason they would be detrimental to navigation in the end.

A large measure of success has been obtained in improving low water navigation by the use of contraction works. As an experiment two reaches were taken by the Mississippi River Commission for a trial of this class of work. Plum Point Reach, about sixty miles above Memphis, Tenn., and Lake Providence Reach, about the same distance above Vicksburg, Miss. These reaches were selected on account of having the least depth of water over the shoals of any on the lower river, and as presenting the greatest obstacles to navigation during low water.

The contraction works as constructed essentially consisted of a series of permeable pile-dikes, with wattling of brush between the piles, the foots of the dikes protected by willow brush mats to prevent scour. These dikes were built out from the shore or on sand bars in shoal water, sometimes in series, to deflect the flow and concentrate it at low stages in the low water channel and at the same time to accelerate the building up of the bars where necessary to better define the low water channel between them.

While generally quite satisfactory results were obtained in both reaches so far as the improvement of the low water channel was concerned, and it was found practicable to modify by their use the direction of the river channel from one side of the river to the other, as was done on the Lake Providence Reach at Stack Island, and also by means of these dikes to hasten the filling up of the Island Chutes, still the works themselves were not permanent, the cottonwood piles and willow wattlings of which they were constructed rapidly deteriorating, as the dikes were exposed during low stages, at the same time many of these dikes were built on sand bars which were liable to be undermined and destroyed after the floods by a change in the channel. The obstructions formed by these dikes to the free discharge of the river at higher stages was also objectionable as reducing the area of the river bed.

The method of improving the navigable channel at low water now adopted, is dredging, and while this can hardly be claimed as a permanent low water improvement, the work done has been of great benefit to navigation. This has been fully demonstrated by the work done in the last two years.

Under the direction of the Mississippi River Commission, who have charge of the improvement of the river, a number of powerful hydraulic dredges have been constructed with the necessary tenders, tow boats and appliances, to move rapidly from place to place where their services might be required to dredge out channels to aid navigation.

This immense plant can be rapidly distributed at any points where work is necessary and the last season's work has demonstrated the fact that in a few days the shoals across a bar can be rapidly removed and safe passage insured with but little delay to navigation.

The advantage of this method over contraction work is that results can be obtained at once, the difficulties to navigation ameliorated or removed while at the same time the river bed is left free of any obstructions that would interfere with the rapid discharge of the river at flood stages.

These dredges are of the latest design, have many novel features, are of enormous capacity and capable of moving an immense quantity of material in an almost incredible short space of time.

One of the greatest difficulties to be overcome in any plan looking to the permanent improvement of the river is to provide for the stability of the banks and thus prevent the continued changes in the bed of the river. These changes are constantly occurring. The banks in the concave bends are being undermined and eroded by the action of the current and caving into the river; the material being swept away and deposited on some shoal near the vicinity or carried still further on to add to already existing bars or to form new ones.

The greatest activity of caving generally occurs immediately after a long continued flood, during or after a rapid decline, although rapid caving often takes place during low stages. In some bends the river rarely caves except at high water, in others the caving takes place at medium and low stages.

This caving is due primarily to the action of the current deepening the river bed near the bank by erosion, rendering the upper bank too steep to retain its slope when the support of the water is withdrawn as the river falls; from the displacement of an under strata of quicksand in the bank, which leaves void and allows the bank to settle bodily; or from the effect of drainage through the pervious material of which the bank is composed; any one, or a combination of these causes may induce caving.

Two distinct methods of bank protection have been employed to render the bank stable and prevent caving—spur dikes and detached or continuous revetment.

The essential features of the spur dikes as constructed are: a foundation mattress and cribs built of willow brush and poles, or a combination of willow brush and sawed lumber; the cribs being placed at right angles to the bank line, and superimposed on each other so as to give an approximately regular slope from deep water to the bank above water. The grading to a uniform slope of the bank immediately behind the dikes and for some distance above and below, covering the same with a light brush revetment which is held in place by stone riprap. In the latter constructions the brush revetment was omitted, as it was found to deteriorate rapidly, and in its place a greater thickness of stone was used.

The method in detail of the construction of the cribs and mattresses were somewhat different in the upper part of the river to those employed in the New Orleans harbor.

Those built at Columbus, Memphis, Helena and Greenville were composed almost entirely of willow poles and brush. The foundation mat had a length of about two hundred feet along the bank, and extended out into the river beyond the foot of the bank from two hundred and fifty to four hundred feet, depending on the depth of the water. The aim being to reach out into or beyond the deepest water wherever practicable. These sills or foundation mats were from ten to twelve inches in thickness, made by weaving the brush on willow poles spaced about eight feet apart, the whole construction securely held together by wire, spikes, iron rods and wire cable. On top of the mat was placed one or two tiers of poles laid transverse and crosswise, dividing the mat into a series of stalls or pockets to hold the stone ballast, with which the mat was sunk in place, when the bottom slope of the river was steep.

This form of mat, known as the woven mat, has been superseded by the fascine mat which contains a great deal more material, is more pliable, stronger, and has given much more satisfactory results, a description of which will be given later.

The top cribs of the spurs were usually eight feet wide and from five to seven feet in height, the next tier underneath sixteen feet wide, each tier towards the bottom increasing in width sixteen feet so as to allow for an off-set in each tier on each side of eight feet. The length of these cribs depended on the shape of the bottom, so that when finished the upper edge of the spur had a fairly regular slope of between three and four to one. The cribs extended up the slope a considerable distance, in some cases to the top of the bank. Each sill or foundation mat was made in one piece on boats specially designed for the purpose and launched into the water as built at the point where it was to be sunk, being held by mooring lines or cables to the shore; these were removed after the mat was in place on the bottom. The cribs were formed on the same barges and when about half finished launched off of the barges and finished in the water.

The bottoms of the cribs were formed of layers of brush placed alternately, lengthwise and crosswise, the frame work was generally made of willow poles, spaces or pockets being left in the body of the cribs to hold the stone ballast with which they were loaded in order to sink them in place. The whole construction was well bound and fastened together with iron rods, wire, spikes, and wire cables.

These spurs were designed to protect the portion of the bank immediately in front, and by inducing a fill or deposit between them protect the intermediate space. The spurs were placed generally about five hundred feet apart, the distance between them being dependant somewhat on the configuration of the bank, depth of water and velocity of current.

In constructing the sills in the New Orleans harbor the mats were made in several sections and of greater thickness, the sections afterwards joined and fastened together to form the foundation mat. A greater proportion of sawed lumber was used in building the cribs, and instead of iron tie-rods and bolts, wooden stanchions were used.

Plans showing the details of construction used in building spurs at Greenville and New Orleans were given at length in the report of the Mississippi River Commission for the year 1888.

While the action of spurs has not been altogether satisfactory as a revetment, they have required but little repair. The upper four dikes of the original ten dikes built in Greenville in 1887, as well as the two above these, built in 1889, were destroyed by the caving back of the bend above, allowing the river during the high water of 1891 to form a channel between the shore ends and the bank. The bank recession at this locality in three months was from two hundred and fifty to nine hundred feet, at present the main river is between where these dikes were and the present shore line on the Mississippi side.

The defect of spurs as a revetment for bank protection is the under-cutting near their outer ends and the undermining due to the eddy action set up between them, in a great many cases necessitating the placing of revetment between the dikes to prevent the caving extending back so as to endanger the shore ends of the spurs.

On another page is a view of one of the dikes in process of construction at Greenville, and is a fair representative of the manner of construction used in the upper parts of the river.

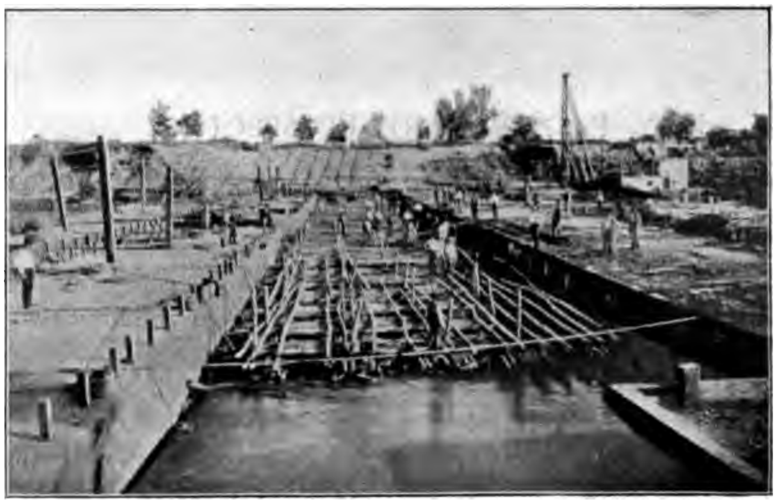
The cost of bank protection by spurs placed five hundred feet apart would be about twenty dollars per lineal foot, or about two-thirds the cost of continuous revetment as now constructed. The cost of the spurs built at Greenville was approximately ten thousand dollars each.

The lower six dikes, built in 1887 at Greenville, are still intact; the upper six, as before noted, were destroyed by the caving back of the bend above flanking their shore ends. The dikes below Memphis have served the purpose for which they were constructed and at the other points are stated to have given fairly satisfactory results.

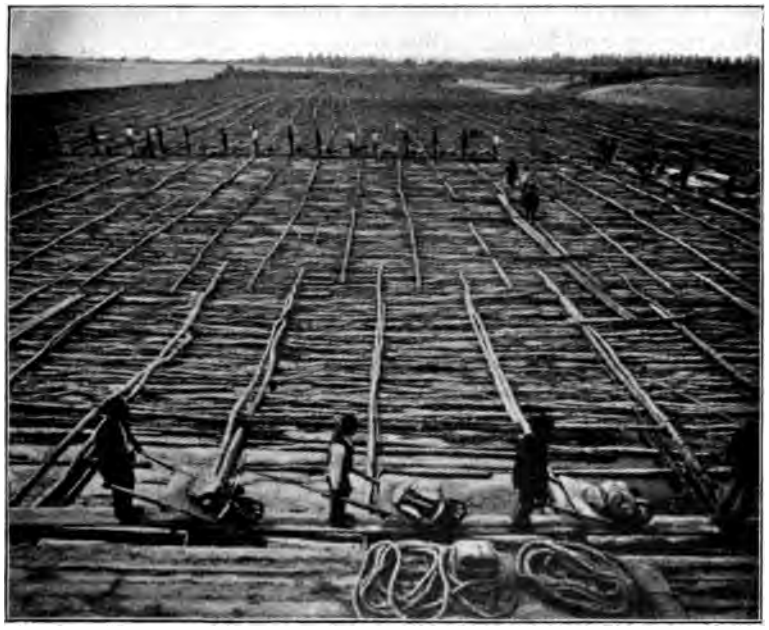
In 1888 a system of detached revetment consisting of patches of continuous woven mat revetment eleven hundred feet long, separated by intervals of unprotected bank, three hundred feet, four hundred feet and five hundred feet long was tried at Plum Point Reach. This was only partially successful as the bank caved away in the spaces between the mats ultimately doing great injury to the part of the bank which had been revetted.

The method of protecting a caving bank by continuous revetment as now generally followed, is:

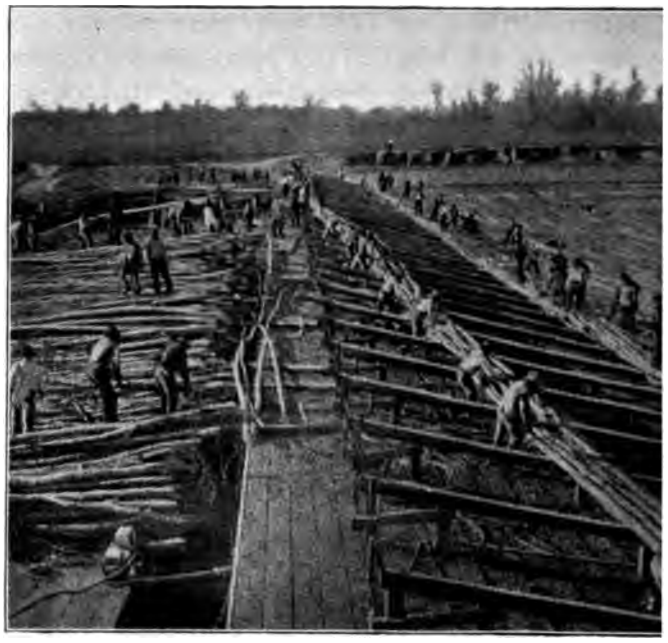
First. To grade the upper bank to a practically uniform slope of from three to four to one. This is usually done before the mats are constructed, although in some instances it has been found advisable to do the grading afterwards on account of the character of the material. This grading is usually done by a hydraulic grader especially designed for the purpose with powerful pumps, forcing water at one hundred and sixty pounds pressure through a line of four-inch hose and discharging through a nozzle from one and one-half to one and three-quarters inches in diameter directed against the steep bank. Usually the banks can be brought to a fairly uniform grade by this means, but in some cases where the material is fine sand or silt, the slope gullies badly and large holes are washed out by the force of the stream, which require filling. Scrapers and shovels are used for this purpose and for smoothing the irregularities left by the grader. The top of the banks is from thirty to forty feet above low water and in many cases with a very steep slope, in fact nearly vertical; to bring these banks to an even grade requires the removal of from ten thousand to fifteen thousand cubic yards of material every one hundred lineal



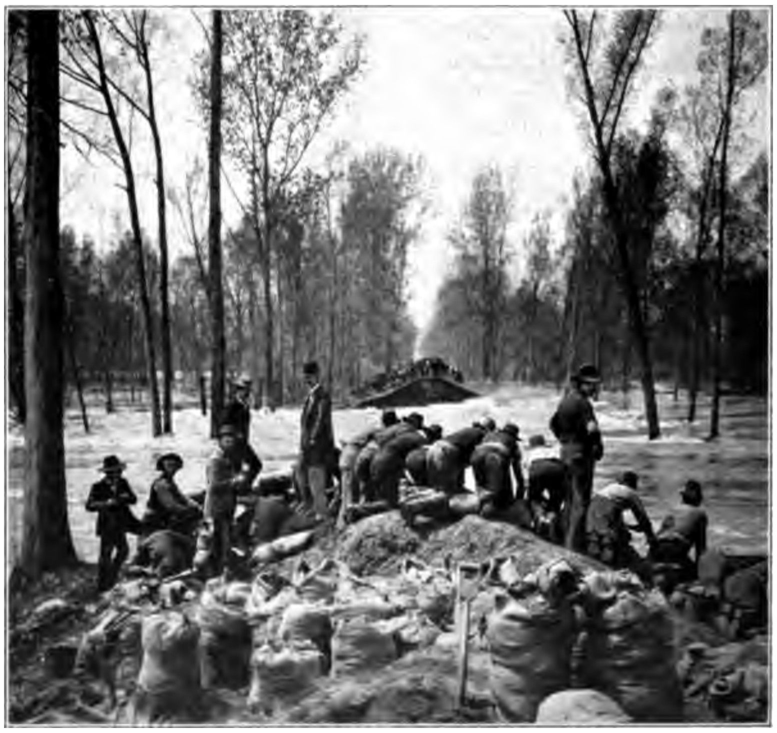
CONSTRUCTING SUBMERGED SPUR.



FASCINE MATTRESS COMPLETED.



BUILDING FASCINE MATTRESS.



TYING ENDS OF LEVEE TO PREVENT WIDENING OF BREAK.

feet of bank. The bulk of this material can be cheaply and expeditiously moved by this method of grading and if the material is suitable the grade is left smooth and even.

When the under-water slope is very steep it sometimes happens that the bank caves after being graded before the foot of the under-water slope can be protected by a mattress.

Plates A1 and A2 show a bank of this class in the process of caving. This instance occurred in the writer's experience in front of Greenville, Miss. About one thousand lineal feet of bank had been graded at a very considerable expense with scrapers and shovels, as it was not deemed advisable to use the hydraulic grader on account of the proximity of the main levee which it was feared might be injured. The slope had nearly been finished when suddenly, without warning, the bank began to cave, and in a few minutes the entire graded portion caved into the river, nearly swamping the grader and rendering necessary the regrading of the entire slope.

Second. After the upper bank has been brought to a uniform slope the next step is the construction of the mattress which is to form the subaqueous revetment. These mattresses are from two hundred to three hundred feet wide and of varying lengths, depending upon locality, depth and velocity of current and stage of water. The usual lengths are from six hundred to twelve hundred feet.

The old style of woven mat, which has heretofore been used, has been discarded and replaced with the fascine type during the past few years, on account of its greater pliability allowing it to better adjust itself to changes in the bottom, and its greater compactness and thickness affording better protection against scour. A description of building fascine mats in the Third District is given below, and in all except some minor details will answer as a general description of this class of work on the river.

These mattresses are constructed of willow brush and poles, the dimensions of the brush are from two to four inches at the butts, and from thirty to fifty feet long, and of the poles from three to six inches in diameter at the butts and from thirty to thirty-three feet in length.

This material is cut on the sand bars and banks of the river, loaded on barges and transported to the site of the work where it is made into fascines forming the mattresses.

The dimensions of the fascines are from twelve to fifteen inches in diameter when completed and in place in the mat, each fascine being continuous across the entire width of the mat.

The fascines are made and put together on mat boats, or weaving barges, specially designed for the purpose. These boats are one hundred and sixty feet long, thirty-eight feet wide and five feet deep. Two boats are lashed together, end to end, making practically a single boat three hundred and twenty feet long, skids eight feet apart are constructed across these boats above the deck, these have an inclination of one on four to allow the mattress to slide off readily when being launched. The skids extend out beyond the side of the boat fourteen feet, so that the ends of the skids are about at the water's surface, and the change in direction of the completed portion of the mat on the water and that lying on the skids is not abrupt. Behind the skids a platform is constructed above the deck of the mat boat on which the men stand while making the fascines, the material being delivered on barges moored to the lower side of the mat boat convenient for handling.

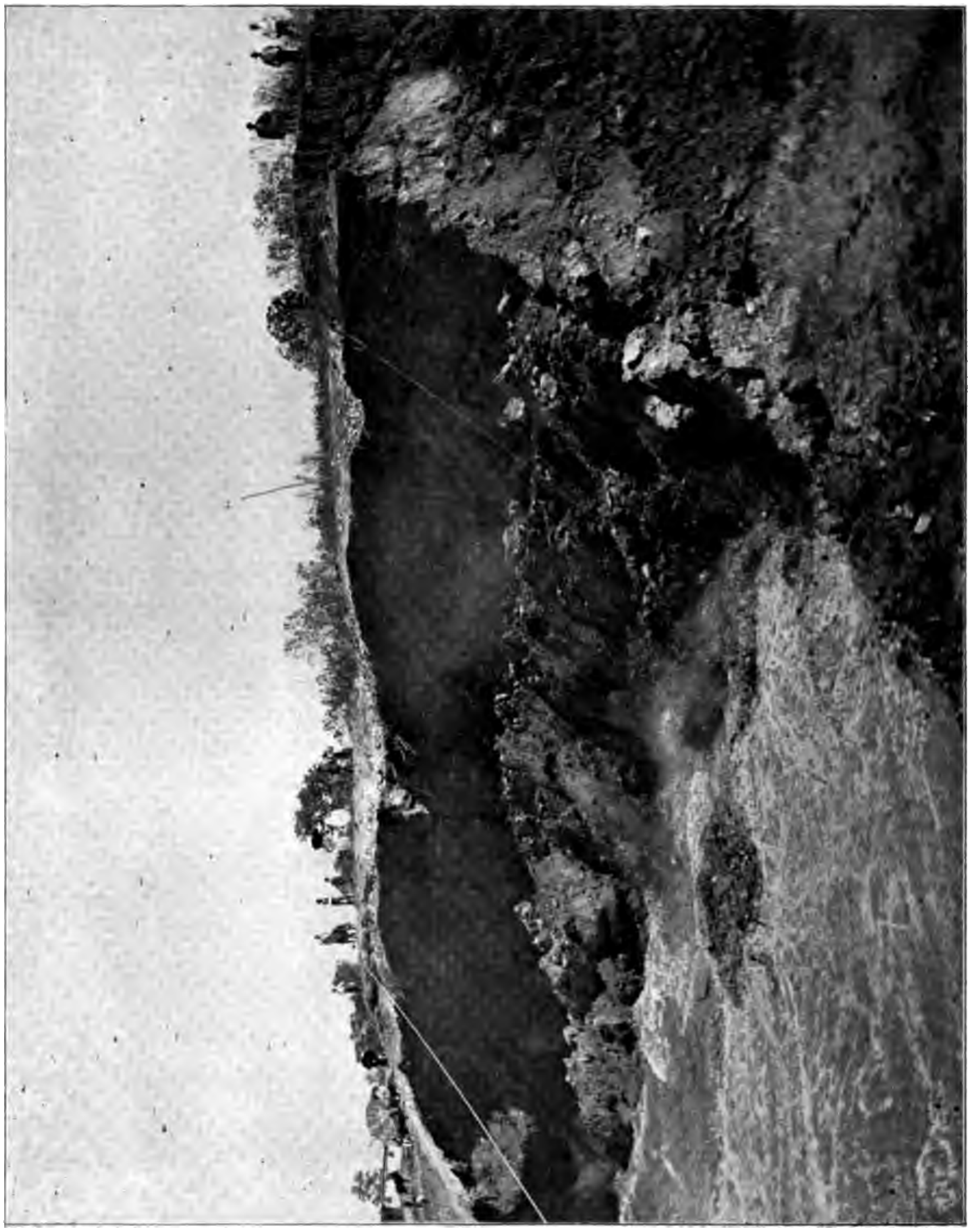
At the end of each skid at the platform is an iron yoke in which the fascines are formed, pivoted so as to swing back when the fascine is finished, and allow the fascine to slide down the skids to be incorporated in the mat.

Under the platform at each skid are placed reels of wire strand which form the bottom cables, these underneath cables extend under the mat the full length of the mat in one continuous length.

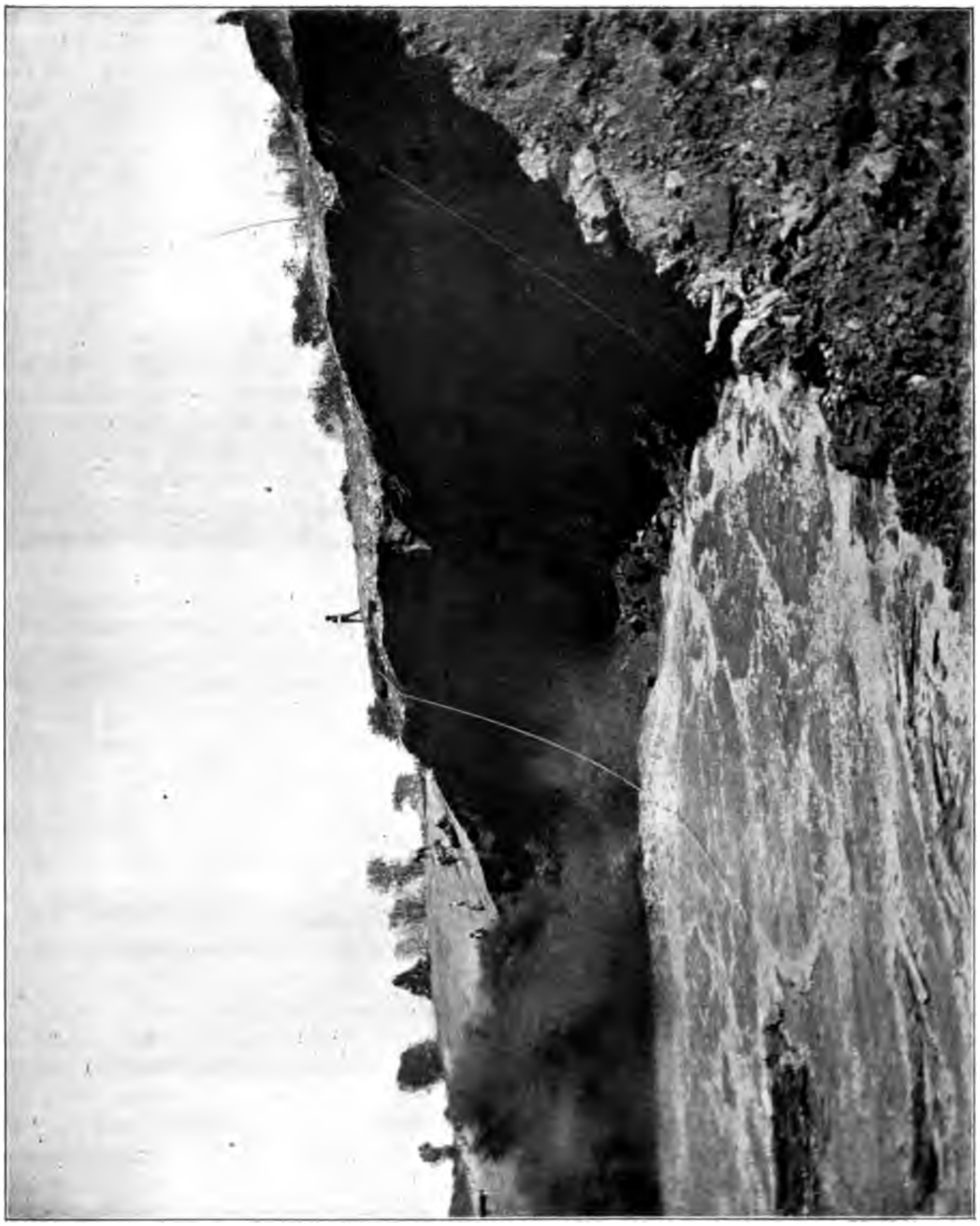
The general dimensions of the bottom cables are five-sixteenths inches in diameter, five-eighths inches being used near the outer edge and at intervals through the outer one-half of the mat, three eight-inch cables are used in place of the five-sixteenths to give additional strength in strong currents.

The wire strand used is composed of galvanized steel wire annealed, the five-eighths-inch cables having nineteen wires to the strand and the smaller sizes seven. In fastening the sewing cables to the longitudinal cables clips or clamps are used every ten feet.

The silicon bronze wire used for binding the poles to the fascines is No. 9, and the galvanized wire used for other fastening is No. 12.



A1. BANK CAVING (FIRST VIEW)



A2. BANK CAVING (SECOND VIEW)

In building a fascine mat the head of the mat is first constructed. This consists of a header which is formed of large poles built in the form of a fascine from two to two and one-half feet in diameter, securely spiked and bound together with wire and cable; a second header is built about six feet below this, around both these headers are the straps to which are fastened the shackles or head cables that hold the mattress in place during construction and sinking. These straps are five-eights-inch strand, one double strap to each head cable, the distances between the head cables vary from eight feet at the outer edge to sixty or even eighty feet inshore, depending on the depth of water and velocity of the current.

The head of the mat is built on the mat barges and held up by slip lines on the mooring barges which are placed at right angles to the shore.

The mooring barges are held in position by lines and cables fastened to the shore, and the mat itself is held in place during construction by independent wire cables one inch in diameter passing under the mooring barges to other fastenings on shore; the length of these head cables vary from eight hundred to fourteen hundred feet, depending on the configuration of the bank; their number depending on length of mat, velocity of current and stage of water.

The method of building fascines is to lay the brush in the yokes as it is taken from the material barges, care being used to distribute the butts and reverse the direction of the brush so that the fascine will be of uniform strength. When the yokes are filled the fascine is held loosely together by passing around it a No. 12 wire at intervals of about fifteen or twenty feet, the yokes are swung back by levers that operate a number of yokes at once and the fascine slides down the skids to be incorporated in the mat. The sewing cable, one-quarter inch in diameter, is then passed over the fascine, then down and under it and around the bottom cable and up again between the fascine and the one already finished in the mat. A set of blocks is then attached to the sewing cable and the cable hauled taut, the brush in the fascines being at the same time compacted by pounding with wooden mauls. The sewing cable is then fastened to the fascines with staples, or clamped to the bottom cable to hold the strain until another fascine is put in place. The sewing cable is clamped to the bottom cable at intervals of ten feet as the mat is built, so that the fascine cannot slip apart. This is continued until the mat is of the desired length.

Occasionally to give additional strength cables of three-eighths or five-eighths inch strand are laid on top of the mat, these strands are fastened to the level of the mat similar to the under neath cables and clamped to the weaving strand. After twenty or twenty-five feet of the mat has been finished on the skids, it is launched by releasing the tension on the under cables, which are wound on reels underneath the platform and held taut by brakes, and slacking the dropping lines fastened to the mooring barges and mat boats. These lines are two inches in diameter, one at each end and one in the middle. Longitudinal lines of poles are placed on top of the mat eight feet apart and are wired to the mat with silicon bronze wire at intervals of from eight to ten feet. The poles are not spliced so as to allow of greater pliability to the mat. On top of the longitudinal poles a series of poles are placed transverse, extending from the outer edge of the mat in towards the shore a distance of from thirty to fifty feet. These are securely wired and spiked to the under poles and form cribs or pockets to prevent the stone from sliding off the mat where the under-water section of the bottom is steep. After being completed the mat is ballasted by evenly distributing from stone barges moored along the outside of the mat a sufficient quantity of stone to destroy the bouyancy of the mat and submerge it nearly to the water's surface; this stone is usually distributed with wheelbarrows, about one hundred pounds per square yard of stone is usually required for this purpose. When this has been done additional stone is thrown on the head of the mat from the mooring barges to sink it sufficiently to allow loaded barges of stone to be floated across the mat immediately below the mooring barges. These barges are then lashed together, end to end, extending across the full width of the mat, and allowed to drift down over the mat, being regulated by dropping lines from the mooring barges, a large force of men on the barges at the same time rapidly throwing off stone on the partially submerged mat until it sinks to its place on the bottom. Each mat as it is constructed, overlaps the preceding one from fifteen to twenty-five feet.

After the mat is in place the mooring cables are unfastened from the head of the mat, the mooring barges shifted to a new position and the process is repeated until the whole length of bank to be revetted is covered.

Third. The upper bank slope above low water, which has previously been brought to a uniform grade, is then covered with stone rip-rap closely laid by hand, the thickness of the covering varying from six inches, where not exposed to strong currents, to ten inches in more exposed places.

The construction and sinking of these large mattresses at times present many difficulties. The principal danger of loss or disaster in sinking is due to a sudden rise in the river which brings down great quantities of drift. This accumulates under the mooring barges and the mat itself inducing excessive strains on the mooring lines and the mat.

Mats have been torn apart from this cause and lost. When it is considered that some of the larger mats contain more than eight acres of material, the difficulty of holding this mass in a current of between three and four miles per hour, and sinking it safely to the bottom with a depth of water from sixty to eighty feet, some idea of the magnitude and risk of the undertaking will be understood.

The average quantity of material required for a lineal foot of bank revetment, with a sub-aqueous mat three hundred feet wide of the fascine type, and the upper bank slope paved with rip-rap from six to ten inches in depth, is as follows:

Brush, per lineal foot	5.0	cords
Poles, per lineal foot	0.2	cords
Wire cable and wire strand	44.0	pounds
Wire spikes	0.2	pounds
Wire staples	0.4	pounds
Galvanized wire	11.0	pounds
Silicon bronze wire	4.0	pounds
Cable clamps	1.5	pounds
Stone	6.5	cu. yds.

The cost per lineal foot of the completed work may be taken as about $30.00.

The excessive cost of this class of work has necessarily limited its general use, and until some cheaper plan is devised this method of protection will no doubt be confined to the most important points and used as a protection to important levees situated near the river banks, to prevent cut-offs; and the caving in front of the towns and cities.

Below is given the plant required for a large party engaged in this work, capable of completing in one low water season (about seven months), from nine to ten thousand lineal feet:

Number and Designation.	Value.
2 tow boats	$ 80,000.00
1 harbor boat or tug	8,000.00
5 boats for men's quarters	20,000.00
4 mat boats	20,000.00
4 mooring barges	16,000.00
30 material barges	90,000.00
4 fuel boats	8,000.00
2 hydraulic graders	40,000.00
20 skiffs and yawls	1,000.00
Tools and mess outfits	5,000.00
Total	$288,000.00

The revetment for the protection of caving banks since its inception has shown a continual and gradual increase in the thickness and width, beginning with short, narrow mats of one hundred feet or so in width, of slight structure, until at the present the widths of the standard mats are from two and one-half to three times the width of those first constructed, often a thousand feet or more in length and containing more than twice the quantity of material.

The latter mats are the largest and most substantial of any built and used for river improvement in the world, and their successful construction and manipulation in sinking has come from the skill and knowledge derived from years of experience.

While always successful to a certain extent in accomplishing the purpose for which they were designed, they are all subject to an attack along their outer edges, and through the body of the mats. In strong currents the effect has been to countermine their outer edges, or even scour through the mats themselves.

To provide against serious injury from these attacks it was found necessary to more than double the thickness and width of the mats as originally built and also to make them more pliable, so that they would more readily adjust themselves to changes in the bottom. These requirements have led to the development of the present fascine type of mattress above described, which may be taken as perhaps the best and strongest mat of this class yet devised for revetment purposes.

It is not the intention of this paper to discuss the merits of levees as adjuncts to channel improvement.

The effect on the low water channel of confining the flood waters between levees is a subject that has not been thoroughly investigated and upon which we have comparatively little data.

Levees, by increasing the heights of the natural banks of the river and confining the flood discharge between them and increasing the velocity of current, have the effect of enlarging the high water channel, and at the same time the result of confining the discharge within narrower limits, while increasing the depth of water also increases the height of the flood.

The great benefit of levees is in protecting the valley from annual inundations and facilitating navigation and commercial intercourse during the time of floods by providing artificial banks. The levee system is being gradually perfected and as the work approaches completion we shall have less and less of disastrous floods on the Lower Mississippi.

SOME OF THE MEN WHO BUILD LEVEES ON THE GREAT MISSISSIPPI—A GROUP AT A "LEVEE LETTING" AT GREENVILLE, MISS.

THE MISSISSIPPI RIVER—WHAT IT NEEDS AND WHY IT NEEDS IT

BY SMITH S. LEACH, MAJ. CORPS OF ENGINEERS, U. S. A.

The popular conception of the Mississippi river is that it is simply a stream of water; that its channel is nothing more than a containing vessel, oblivious of its contents; that its floods are only the spilling out of a portion of the water at times when the vessel is too small for its purpose, and that the remedy for such an overflowing river is the same as for an overflowing tub.

The Mississippi is a stream of water, to be sure, but it is very much more than that. The water carries in suspension a varying but always considerable quantity of sediment. Its channel is a plastic conduit, formed by the river itself, and as sensitive to its demands as a mother to the caress of her child, undergoing incessant changes in response to the moods of the current. These changes, so far as they affect the capacity of the channel to do its work, are of two kinds, one of which makes the bed larger and is beneficial, while the other makes it smaller and is detrimental. Both depend upon the ability of the water, considered as a vehicle, to carry the sediment, considered as its load. The vehicular power of the water is derived solely from the fact that it is in motion, and the best index of this power is the amount of motion as represented in the velocity. Changes which make the channel larger are caused by the moving water taking up material from the bed and carrying it away and are the result of accelerated velocity. Changes which make the channel smaller are caused by a portion of the sediment in suspension being deposited on the bottom and are the result of diminished velocity. The conditions of the problem are so infinitely various that no exact relation has been or can be established between the velocity of flowing water and its sediment-carrying power. But thousands of concordant observations demonstrate that no matter with what velocity the river is flowing, and no matter what amount of sediment it may be carrying, if the velocity be decreased, some of the sediment will be deposited. The converse of the proposition, though equally true in the aggregate, is more subject to exception in individual cases. A man is ever more ready to lay down a burden than to take one up, and can carry a load which he could not lift, and a river may be excused for manifesting a like disposition. Changes unfavorable to the efficiency of the channel being produced with greater facility than those favorable, the general tendency of the river in its natural condition is to deteriorate.

The channel which the river now has is the net result of its present silt-transporting power. Any channel which it may have in the future will be the result of the same cause, the then silt-transporting power, and will be better or worse than the present one accordingly as the silt-moving power of the stream has been increased or diminished by natural agencies or human effort. In all questions of the regimen of this river and of changes in it for the purpose of improvement, the matter of first and paramount importance is the effect upon the velocity. Every scheme advanced, no matter by whom or for what reasons, should be at once subjected to this crucial test and made to stand or fall by the result. Any plan, the result of which is to diminish the velocity throughout a section of the channel, is vicious and the advantages promised by it illusory. Plans which tend to conserve or increase the velocity are beneficial, and any disadvantages which may accompany them will be temporary. The velocity is the unerring touchstone which distinguishes the true metal of every applicant for favor, which discovers an enemy in the flattering and boastful outlet, and discloses a friend in the conservative and commonplace levee.

The escape of water from the channel of the river at any point or under any circumstances is accompanied by a reduction of velocity below the point of escape, and by deposits in the area of reduced velocity. A steeper slope is required to maintain the discharge through the diminished cross-section, and the increased slope is obtainable only by an increased height of flood surface above the obstruction. Numerous actual measurements in the bed of the river preclude any doubt of the truth of this proposition. They prove that the escape of water from the channel is accompanied by deposits below, which fact granted, the other changes stated follow as consequences of the elementary laws of hydraulics. The results have been published in detail and so widely distributed that persons desiring information can easily obtain them, and those otherwise inclined would not be benefited by their repetition here. One instance, however, of recent occurrence and of momentous significance will be given.

During the flood of 1890 a crevasse in the levee at Nita, La., on the east bank, about 60 miles above New Orleans, having a width of 3,000 feet and a depth of 15 feet, was found by actual measurement to have a discharge of 400,000 cubic feet per second, or 30 per cent of the entire discharge of the river immediately above the crevasse. As the result of this great outlet the depression of flood surface immediately below the break, where there is a permanent gauge, was one and one-half feet, while at New Orleans, 60 miles below, it was only one foot, and at Plaquemine, 50 miles above, this crevasse had no effect at all. This case shows conclusively that even the engineers who have opposed outlets for the reasons above set forth, have conceded entirely too much as to the immediate relief afforded by depression of flood surface, both in its amount and its extent, and have, by their frankness, given unwarranted aid and comfort to the outlet supporters. That outlets must disappoint the expectations of their advocates as to the amount of lowering of flood surface, for a given volume to escape, was noted by the able pioneers in this subject, Generals Humphreys and Abbott. Lacking actual measurements, they supported the proposition by a very ingenious method of indirect proof, which showed in part, but not completely, the futility of outlets as a means of flood relief. In the case of this year, just cited, an actual outlet was in operation, and all the quantities involved were directly measured. It is a gigantic clinic upon an aggravated case of the outlet plague, and shows that as a means of inoculation against overflows the outlet is a distinct failure. It has long been conceded that nothing in the way of benefits could be looked for from an outlet, except a temporary local depression of flood surface proportionate to the amount of water taken out, and now it appears that this last surviving hope is shattered. The relief afforded is so trifling as compared with the effort and risk of obtaining it, the effect so insignificant as compared with its cause, that if all the evils of outlets were discredited, there would still be no excuse for making them. A mountain in labor to bring forth a mouse does not surpass such a project as an example of fruitless endeavor.

The size and form of the channel are the results of the effort of the stream, the size determining its sufficiency as a flood chain, and the form its usefulness as a route for navigation. That both are defective is not because the energy is lacking, but because it is misdirected. It has already been intimated that less energy is required to prevent a deposit than to remove it after it is made. So, also, it is far easier to maintain a channel once formed than to open a new one. The river has ample energy to maintain a channel of proper navigable depth and discharging capacity if it can be made to work, as every agency should work to the best advantage and without waste of effort. That it does not so work is due to the fact that the discharge and elevation of the surface are momentarily changing, and with them the positions of bank lines and the location and direction of the line of greatest velocity and maximum effort. No sooner is a sufficient channel obtained in one place than the current leaves it to be obliterated by deposits, while the work which would have easily maintained it is wasted in scouring out a new and inferior one, or perhaps dissipated among several. Every mile of the river is a witness to the truth of this proposition, since the places where the thalweg is stable in position are invariably good, and those where it is shifting are invariably bad. No exception to this rule can be found betwen Cairo and the Gulf.

What nature has failed to do, and what remains for man to accomplish in order to fit the Mississippi river to his wants and uses, is summed up in the one word, control. Guide the current as the skilful workman guides his tool, and it will not fail to carve out a channel commensurate in size with the magnificent agency employed and worthy of the greatest of rivers, traversing and draining the most fruitful and prosperous of countries.

The requisite control is to be obtained by a partial reversal of the present relations of the stream and its bed. It has been shown that the channel is the ready servant, the stream the imperious master. The inconstant current seeks a change, and the subservient shore retires before it. In this respect, as regards the sides of the channel, the present relation of master and slave must be reversed. The servile banks must be strengthened and incited to revolt against their tyrant and to impose a like bondage in return. The current, no longer able to shift at will, devotes its energy to scouring out the bottom, working constantly on the same line and always to the best advantage. The stream, acting under such constraint, will mold its channel to the largest attainable size and discharging capacity, and in the form best adapted to the needs of navigation.

Although this is a statement of theories, it may not be amiss to interject a word as to practice. Types of structures have been evolved in the short experience already had, which may be relied upon to do the work expected of them, and which can be constructed at reasonable cost. A caving bank can be protected or a secondary channel closed with as much certainty as pertains to the building of a road or the digging of a canal. Moreover, these structures have been built at a cost which will allow them to be applied to the entire river without exceeding the sum which the city of Manchester proposes to pay for a canal connecting her with deep water in the Mersey.

Control by means of protected banks is complete and sufficient only so long as the river is within its banks. When it rises above their level the control becomes partial and necessarily inadequate. In years of great floods the surface of the water is above the natural bank level from two months at Cairo to six months at New Orleans. Without artificial restraint nearly one-third of the entire discharge of the river at extreme flood takes place outside its proper channel, as was the case in 1882 above Vicksburg and in 1890 above Helena. The proportion decreases as the bank level is approached, but the aggregate loss of volume during a flood period is enormous It has been shown that the fundamental principle upon which the improvement is based is the control of the water in the channel. To allow large quantities to escape, reaching at times one-third the whole, does violence to every idea which can possibly be associated with the word control. Water flowing in the channel is the agency of improvement, and when any of it escapes a part of the potential goes with it, and a corresponding measure of the improvement is sacrificed. The current is to be guided so as to do the desired work; the more water the more current, and the more current the more work. When the volume is at a maximum the current has its greatest capacity for work, and will then produce results beyond those which it can attain at any other time. To secure the greatest possible improvement of the channel it is necessary that the greatest attainable volume of water be made to flow through the channel. That this condition is not realized when a large volume is escaping over the sides needs but to be stated to be conceded.

The necessary control of the current beyond that produced by the natural banks, reinforced by protective works, is effected by means of artificial embankments placed on the shores, and of sufficient height to restrain the highest floods. Logically they should follow the shape of the banks, and in practice they do so as far as other and controlling conditions permit. Prevention of escape is control in a large measure, and for that purpose levees, as now built, are fully effective, for they limit the escape to the relatively insignificant volume contained between them and the edges of the channel.

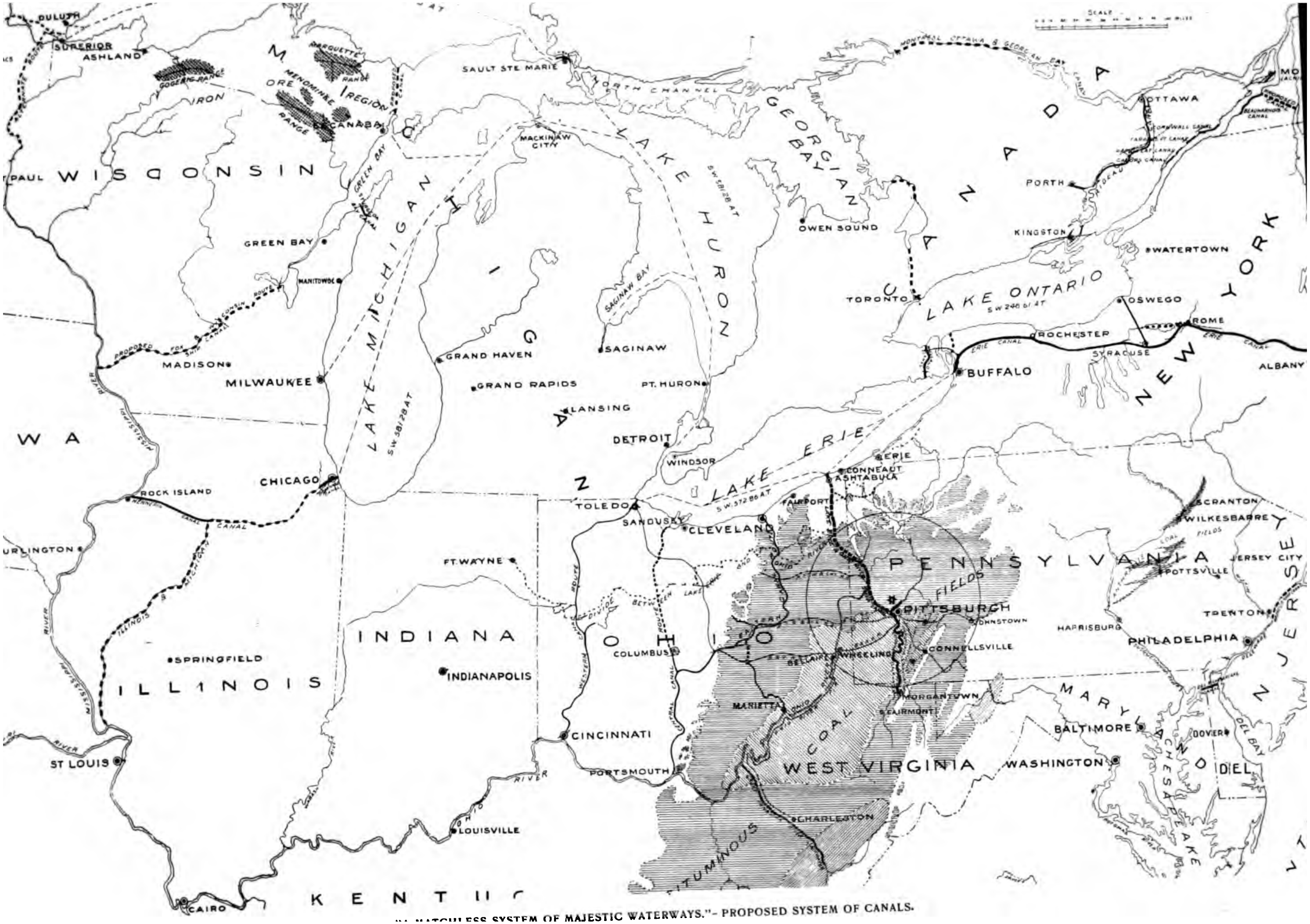
The difference between the effect of a given diminution of velocity in producing deposit and that of equal acceleration in producing scour has been noted. The distinction is a very important one, and finds a new application in this connection. It makes possible a great number of the improved channels in other waters, which have been opened by dredging and have then been maintained by the force of a current which had been powerless to excavate them. Deposit is by its nature a gradual operation, requiring time for its accomplishment, and therefore depending on average conditions. Scour is a more sudden phenomenon, and largely depends on maximum conditions. It is a matter of common observation on all silt-bearing streams that deposits decrease rapidly in rate at higher levels and rarely extend above the average flood plane. The velocity, which represents the possibility of scour, increases regularly when under control to the extreme flood level, the increment for the last foot of rise being as great as for any other foot. A mistaken analogy with the depositing action has caused too much weight to be given to the element of time in producing scour, and has given color to the idea that control of high waters might properly cease at some stage below extreme flood. The utmost limit of channel development, which means the greatest measure of improvement, will result from the greatest intensity of the force which creates the channel and from no other cause. That greatest intensity of errosive force will result from the complete restraint of the greatest floods and from no other cause. Great floods recurring at intervals of several years and confined to the bed of the river will create a channel which but for such floods and such restraint never could be created. That channel periodically established, the lesser intervening floods will maintain at a size greater than they could themselves have produced, so that the degree of improvement as maintained will depend upon the magnitude of the greatest floods which are controlled and will reach a maximum only when all floods are controlled.

In its natural condition the channel deteriorates. The deterioration must be stopped and a condition of improvement substituted. The cause of the deterioration is the escape of water from the channel. The remedy is to remove the cause, which can only be done by confining the floods. The improvement of the channel is to be effected by the control of the current. The control at all stages, within or above the banks, will be more effective if the floods are restrained. To depend upon channel works alone is to attempt the improvement with the causes of deterioration in full activity, and is as great a waste of effort as to draw a wagon with the brake set. The complete restraint of floods stops the deterioration of the channel, and at the same time develops to the highest possible degree the forces which tend to its betterment. By a happy coincidence the construction of levees realizes a combination of the greatest force for improvement and the least resistance to its action. That larger results will be obtained under these conditions than can be hoped for otherwise does not admit of a doubt. That the importance of the Mississippi river, the magnitude of the interests depending upon it, and its influence as a factor in the prosperity of the whole country, deserve and demand the most complete and perfect improvement attainable is equally certain.

If any proposition more than another is inconsistent with everything that has been stated in this paper, it is one which has obtained wide currency and on which opposition to levee building is largely based, that levees cause deposits in the channel and thereby raise the bed of the river. The votaries of this doctrine ignore the testimony of the Mississippi itself, which is conclusive against them, and depend upon an alleged analogy with the Yellow river of China, about which no one knows anything, and with the Po, of which everything that is known refutes their hypothesis.

Another argument against the attempt to confine the floods is that it is an impossible undertaking; that it never has been accomplished and never can be. The facts are that the flood of 1897 was the largest on record from Memphis to the Gulf; that it was confined between levees over the same distance with a loss of only one mile in 200, as against one in 22 in 1882, one in 35 in 1883 and one in 120 in 1884. If this be failure what is success? A reasonable man will not abandon a cherished undertaking while his resources are unexhausted, and his last effort is markedly more successful than any previous one.

With the advantages of levees unappreciated, their difficulties exaggerated and dangers asserted when none exist, it is small wonder that the cause has languished, and that its active advocates have been suspected of carrying their convictions and their purses in the same pocket. Private interest has compelled the residents of the Mississippi valley to study the question, and study it deeply. They have learned by that study that there is a public interest, which will be benefited jointly with their private welfare by the construction and maintenance of a system of levees, and their appeal has no more sinister purpose than to secure an equitable co-operation of that joint interest in the pursuit of the common object.



"A MATCHLESS SYSTEM OF MAJESTIC WATERWAYS."- PROPOSED SYSTEM OF CANALS.

Chas. Scott

"A MATCHLESS SYSTEM OF MAJESTIC WATERWAYS"

BY HON. CHARLES SCOTT, OF MISSISSIPPI

Address of Hon. Charles Scott of Mississippi as Permanent Chairman of Convention on the Improvement of Western Waterways, Memphis, Tenn., November 14, 1899.

Ladies, Gentlemen of the Convention, and Fellow-Citizens:

As I confront this assemblage of distinguished American citizens, delegates from all parts of this imperial valley, I instinctively recall the pleasant fact that history is repeating itself here to-day in this hospitable and progressive city. Who among you, gentlemen, at this bare suggestion, will fail to recall the historic convention that met in the city of Memphis in 1845? It assembled here on November 13 of that year, a notable gathering of strong and distinguished men. In the mind's eye, I can see them now. There they are, over five hundred strong; the intellectual sons of the sunny South, and brainy men from the golden grain fields of the stalwart West. Holding imperial domination over their deliberations, I see the great South Carolinian, Jno. C. Calhoun, gavel in hand, as he arises to address his peers. With countenance "sicklied o'er with the pale cast of thought," and a brow plowed with the deep furrows of melancholy and anxious meditation, he holds his audience entranced as he gazes out from those wondrous, deep sunken eyes; while over all and above all shines the light of a majestic intellect.

What changes, what mighty changes, ladies and gentlemen, have come to us and our common country since the great nullifier, as he was sometimes called, rapped his gavel in Memphis fifty-four years ago!

The lone star of Texas, as you will remember, was then shining over a territory that still preserved its autonomy as a separate and independent republic. Since then it has become a part of the resplendent galaxy of American States, brought there by the influence and powerful intellect of the wonderful man whose name I have just mentioned. Then could be first heard from afar the murmurings of civil discord; and in reading the proceedings of that convention one cannot fail to observe the extreme care of the North and the South, lest the one should touch the keen sensibilities of the other. That strife (alas! not to be avoided) grew louder and louder, until it broke over this fair land in a most terrific struggle, which, thank God, was finally and forever adjusted without loss of sacred honor to either section. (Applause.) And now, my countrymen, this storm allayed, the white and red roses of the North and South will cling together so long as time shall last. (Prolonged applause.)

But, what of the city of Memphis in those days of the long ago? This magnificent city, now the meeting place, or terminus, of twelve lines of busy railroads; the home of ten banking institutions of ample capital; the largest inland cotton market in the world; the largest hardwood lumber market on the continent; the gateway to the fertile fields of Arkansas and Mississippi, was then, ladies, as Cleopatra would have said, "in her green and salid days;" entertaining for the first time perhaps, a large gathering of distinguished strangers within her gates.

But, even then—

"Standing with reluctant feet,
Where the brook and river meet,"

the beauteous young city gave every promise of the future development which has since made her, as one of your local orators recently said, "The Queen City of the Valley, God bless her." (Applause.) And in saying this, believe me, I intend no idle compliment, because from my youth up I have always loved and admired Memphis and her noble people. A Mississippian by birth, it was my good fortune, years ago, to attend her public schools for awhile, and afterwards it fell to my lot to follow the proud oriflamme of her matchless cavalryman, Bedford Forrest, whose brave and daring deeds are destined to live forever in song and story. (Great applause.)

It was doubtless this early promise of future greatness which secured for Memphis the distinction of entertaining the remarkable convention which I have just mentioned. I trust you will pardon me, gentlemen, for dwelling somewhat at length upon that important assemblage. I do so because from it I think we can draw some practical lessons of useful wisdom. First: Let us recall the object of that meeting. For what did those distinguished men assemble here? What brought them together? In answering these questions we must confess that the scope of their labors was far broader and more difficult than ours. They were expected to discover and point out the ways and means for the development of the resources of all the Western and Southern States. Think what a gigantic task! What a wide range for the imagination! What a broad field for the brightest and most aggressive intellect! And yet—and this is the point I desire to make with you, gentlemen of the Convention—when boiled down by the greatest analyst ever known to a long and brilliant line of American statesmen, it resolved itself at last simply into

A QUESTION OF CHEAP AND RAPID TRANSPORTATION.

If there was one characteristic above all others, saving alone the rugged and unswerving integrity of his character, for which Jno. C. Calhoun was justly distinguished, it was for that keen, subtle, penetrating power of analysis, which carried him straight to the heart of his subject, "on wings as swift as meditation, or the thoughts of love." You will not be surprised, then, that going like an arrow to the mark, he used words, which are as pregnant with meaning to-day as they were then, and which I now quote literally from the celebrated speech of Calhoun's, delivered when his eloquent and potential voice was last heard in this admiring city:

"I approach, now, gentlemen, the important question: How shall we, who inhabit this vast region, develop its great resources? For this purpose there is one thing needed, and only one, that is, that we shall get a fair remunerative price for all that we may produce. If we can obtain such price, this vast region, under the active industry of its intelligent and enterprising inhabitants, will become the garden of the world.

"How is this to be effected? There is but one mode by which it can be done, and that is to enlarge our market in proportion to the increase of production. This can be obtained only in one way, and that is by free and ready transit for persons and merchandise between the various portions of this vast region, and between it and the other portions of the Union and the rest of the world." (Applause.)

So said Calhoun. And this question of cheap and rapid transit for persons and merchandise is as important to-day as it was fifty-four years ago. Indeed, it is the same always, yesterday, to-day, and forever. What is individual effort in the way of furnishing transportation on an extensive scale? It is a snare and a delusion. It is like unto sounding brass and a tinkling cymbal. The census of 1880 gives some interesting and instructive statistics along this line. It shows, as a result of investigation, that it costs the producer to remove his grain by wagon from 5 to 10 mills per bushel per mile. Why, gentlemen, any of the railroad corporations, that it is our great American privilege to abuse, can, and do, move a man's grain for him *per ton* at the same price it would cost him to transport it *per bushel*. And with convenient and abundant water transportation it can in many cases be moved still cheaper. In short, this question of cheap and rapid transit is one that concerns now and always the prosperity of the entire country. You should rejoice then and be glad, oh ye dwellers of the valley, that nature has provided you with

A MATCHLESS SYSTEM OF MAJESTIC WATER-WAYS.

(Applause.)

But, these rivers, aptly called by Senator Turley in his eloquent speech this morning, "God's eternal highways," are not presented to us by the hand of nature, as generous as she is, in perfect condition for commercial purposes. They need the aid of art and science to develop them to their fullest extent, and when that is done, gentlemen of the Convention, this fertile valley will at last attain the full measure of its glorious destiny. (Applause.) A talented writer has recently called it "the heart of the country, its granary and its workship," and when our noble and magnificent water-ways are properly improved, as they should be, *and as they must be*, then it will become the numerical, financial, and intellectual center of this, the grandest nation known to ancient or modern civilization. (Applause.)

How, then, is this important work to be accomplished? How, gentlemen of the Convention, except through Congressional appropriations? And this brings us face to face with the practical part of the work of this distinguished assembly. It will be your task to help mold public opinion, and to so direct the public sentiment of the country that when we next apply to Congress for money to improve the vast system of Western water-ways it will flow hitherward in a copious and golden stream. (Applause.)

I know it is said by some, perhaps by many, that "this is an inopportune time to secure government appropriations; that we are now engaged in a tedious and costly war with the Philippines for which enormous sums of money must go out of the public treasury, to the exhaustion of our resources." Now, my fellow-citizens, let me say right here, if it would take one cent from the successful prosecution of a foreign war, I for one would say, let our water-ways remain forever as they are. (Applause.) I am a Democrat. I have never known any other political faith, but, gentlemen, we are one people, one nation, and when we are engaged in war with a foreign foe, it is time for every citizen of this great republic to uphold the hands of the President in his wise and patriotic efforts to maintain the honor and prestige of the American flag. (Great demonstration and applause.) But there *is* no scarcity of money. Bless you, ladies and gentlemen, Miss Columbia can easily spank little Aguinaldo with a slipper in one of her dainty hands while she signs checks with the other for the improvement of our Western water-ways. (Laughter and cheers.) It was only to-day that I noticed a telegram in the great Memphis "daily," the Commercial-Appeal, from Washington City, alluding to the rapid growth of the surplus in the treasury. The writer said, among other things, that if it continued to grow at the present rate, by the 1st of September next, the treasury would have as a cash balance more than three hundred and fifty millions of dollars. Why not relieve the officials, pray, of some of this embarrassment? We can use $100,000,000 of it so quick it will make their heads swim, and every dollar of it will be so much bread cast upon the *waters* to return to the nation after many days. (Applause.)

I know there are always objectors, and objectors loud and long, to these expenditures for internal improvements. It has been ever thus. But the day has passed when a statesman can safely bottom his reputation on a proposition of that kind. The "watchdog" business has been overdone. The fact is, it is now pretty well conceded that these "watchdogs of the treasury," as they are sometimes called, are those dogs who desire to take both the meat and the bones for their own special districts, and leave the other dogs to be content with the shadow. (Laughter.) These "fanatics of conservatism," as some one, I believe Carl Schurz, as aptly called them, have gone down forever before a pronounced public sentiment, which permeates this whole country in favor of a wise and progressive system of internal improvements. Uncle Sam has concluded, at last, I am glad to say, to put some part of his money where it will do the most good, in the betterment of the country's water-ways. (Applause.)

Now, gentlemen, I shall not presume to outline any part of your important labors. In all such matters your judgment and wisdom are your best and surest guides.

You are here as the representatives of 35,000,000 people, inhabiting a territory containing about 41 per cent of the whole area of the United States, eliminating our outlying possessions. It is unavoidable, therefore, that there should be many divergent interests to be considered; but, it is not necessary that any of these interests should clash; at least, to a serious extent. Harmony and cooperation, let me remind you, are essential to our success. We must present now, and always, an unbroken front to Congress, in demanding national aid for the Western water-ways, and then we will not fail to get all we can reasonably desire.

While it is unnecessary for me to go into details, I feel that a few suggestions may not be out of place. And the first thing that occurs to me is this:

THE SMALLER WATER-WAYS

of the country should receive due consideration at your hands, and more liberal treatment at the hands of the general government. (Applause.) Many of these smaller streams, as the great Levee Champion, General Catchings, well said this morning, are almost unknown outside of the committee room of the Rivers and Harbors Committee. And yet they are of vast importance to the country and its development. I am fully aware of the fact that the appropriations to the smaller streams have been effectively used more than once as an argument against the rivers and harbors bill. But, it has always occurred to me that those streams—streams, for instance, like the Ouachita, the Arkansas, the Monongahela, the Yazoo, and hundreds of others—are in every way worthy of Congressional recognition. (Applause.) They are just as important to the people in their vicinity as is the Mississippi river to those who live adjacent to its banks. Indeed, it may be said that *they are as indispensable as the country roads*, to which they may well be likened, and they should be recognized in any intelligent system which seeks to give the country the full benefit of its streams and rivers.

Passing from these smaller water-ways, we are now to consider the great Father of Waters, and find it in need of help throughout its entire course. Commencing at the twin cities of

ST. PAUL AND MINNEAPOLIS,

which, year by year, are reaching out their arms, each to the other, until the time is not far distant when they will at last constitute one magnificent city, the pride of the great Northwest, we find the people there have their peculiar needs, which should be carefully guarded and gratified.

Thence, coming south to

THE MIGHTY MISSOURI RIVER,

twenty-five hundred miles of which are said to be navigable, we find many problems demanding the attention of the general government. This noble stream flowing through the great grain fields of the Northwest, is of such overshadowing importance to all that section of our common country that its just demands should and will receive your ready and most cordial recognition. (Applause.)

It is almost unnecessary for me to call your attention to the river in the vicinity of

THE SUPERB CITY OF ST. LOUIS.

It must be evident to you from her large and intelligent delegation now on the floor of this Convention, that *she* will be heard from in due season, and her just and urgent demands for deep water, will, I am sure, be heartily re-echoed by every member of this Convention.

The Mississippi River Commission have already taken vigorous steps in that direction, and the powerful dredges built under their inspiration, are the most wonderful machines in that line that have ever been constructed. As this fleet of dredges is increased as rapidly as the appropriations justify, and as the other plans of the river commission are developed to the point of consummation, you will see the Stars and Stripes all the way from your new city of Manila, if you please, carried by your astonished bluffs on ocean steamers of heavy tonnage, as they pass onward with full cargoes to the great city of St. Louis. (Applause.)

By the way, gentlemen, I digress a moment to pay a brief tribute to the important and valuable work of

THE MISSISSIPPI RIVER COMMISSION,

whose arduous and difficult labors are not sufficiently understood by the general public, I fear, to be properly appreciated. Let me say they are a body of patriotic, capable and conscientious men, and we should, both from the standpoint of policy and justice, hasten now and always to hold up their hands. I believe that all the difficult problems germane to the river and its regimen can best be solved under the wise and conservative management of a commission like this. And it would be a bad day indeed for the Mississippi Valley, if the commission was ever abolished, or its jurisdiction curtailed. They have done well, exceedingly well, and are fully entitled to the thanks of a grateful people. (Applause.)

To return to my subject. What shall I say of

THE OHIO RIVER,

the most beautiful of all our Western streams?

Did you ever happen to be away up the Ohio river, on one of its long, picturesque reaches, near the close of a summer's day? If so, your nature is more phlegmatic than mine, if your soul did not respond to the beauties of the scene, as you gazed on its sparkling waters, and enjoyed its graceful and romantic shores. Why, gentlemen, the Ohio, I think you will readily agree with me, is entitled to everything she may demand. Not only by reason of the great commerce that is constantly borne upon her noble bosom, but because we should remember that from the Ohio came the first inspiration for internal improvements. On her northern shore, Senator Worthington, of Ohio, the father of the doctrine of internal improvements, was the first to agitate this important subject in the halls of Congress; while on her southern bank was his co-laborer, the "Great Harry of the West," whose inspired voice first successfully fought its arduous battles. (Applause.) I see my old friend from Pittsburg, Captain Dravo, joins heartily in applauding this sentiment, and when you hear from him later, gentlemen, you will observe that he, himself, is a mighty apostle of the water-ways. (Laughter and applause.)

And now, gentlemen, I approach what is to the dwellers of the lower valley a question of *supreme importance*. It is needless for me to say that I allude to

THE RECLAMATION AND PROTECTION OF THE VAST ALLUVIAL FIELDS OF THE MISSISSIPPI VALLEY

from the annual floods, which have cost its citizens countless millions of dollars.

The fact of the business is, it is the duty of the government to take charge of improvements of this sort on the Mississippi river, for many and obvious reasons. (Applause.) In doing this there will be no undue stretch of constitutional authority. Even a strict constructionist like Jno. C. Calhoun, found abundant warrant for such wise expenditures. Not only are they fully sanctioned by reason and authority, but the heart of this great nation has been deeply touched by the manifold sufferings of the people of the Mississippi Valley. Besides, it is estimated that there are not less than 13,000,000 of acres of fertile lands that can be reclaimed from the floods and brought under the plow. This would add as much as $200,000,000 annually to the business of the country, giving an impetus to all kinds of improvements, the importance of which we can scarcely estimate.

Much has been done already in the matter under discussion. The levees, through the combined efforts of the government and the riparian States, are being made stronger and better year by year. This will be more thoroughly understood when I tell you that during the great flood of 1882 there were 284 crevasses, which swept away all told fifty-four miles of levees. In 1890 there were only twenty-three crevasses, and the amount of levees destroyed was equal to only four and one-half miles. And since that time, even when the dykes were tried by higher floods, the number of crevasses and the consequent destruction to property have been still further reduced. This subject, gentlemen, is one of transcendent importance, and I trust will be favorably considered by the delegates of this Convention. (Applause.)

Now, passing on, let us consider for a moment the necessities of the river below us. I think you will, one and all, recognize the fact that there should be liberal and adequate appropriations for

THE SOUTHWEST PASS.

This is a matter in which all parts of the valley are alike concerned. With the increased size of ocean vessels, unless the channel is deepened at the mouth of the river, it will be impossible to build up and satisfactorily care for the large export and import trade to which the Mississippi Valley is justly entitled.

A forceful and accomplished writer, Mr. Stuyvesant Fish, in his admirable address recently delivered before the Industrial Commission, and already quoted from this morning by Senator Turley, showed how much less these imports and exports amount to than should be the case when we consider the geographical position of New Orleans and its other advantages. I invite your attention to what Mr. Fish has to say on this subject:

"The line of equal railroad distances to New York and to New Orleans, respectively, may be said to begin on Lake Superior, at the boundary between Wisconsin and the upper peninsula of Michigan, and, following the northern and eastern boundaries of Wisconsin, to pass through Chicago, Ill., run thence southeasterly through Indianapolis, Ind., and Bristol, Tenn., and to reach the Atlantic Coast, near Charleston, S. C. Every point to the south and west of that line is nearer by rail to New Orleans than to New York. It is in that part of the basin of the Mississippi river which lies west of that line that our exportable surplus of breadstuffs and packing house products is made, and, so long as water runs down hill and it costs more to move freight up hill, the natural tendency of that exportable surplus will be to reach the sea at New Orleans and the other Gulf ports. * * *

"No other port in the United States is served by railroads reaching, under single managements, so far and in such varied directions into the interior of the continent. That those railroads ought to bring to and carry from New Orleans vastly more than they do of goods for foreign commerce, is shown by their gross receipts during the past year, from the carriage of passengers and freight, being

$130,637,703, or thirty per cent *more* than the value of all the imports and exports of New Orleans, which, in turn, amounted to $100,090,537."

The causes prohibiting a larger volume of export and import business are not difficult to find. He who runs may read. It simply means that this great Southern gateway to the sea has been too long neglected. The truth is, the mouth of the river was lost sight of, commercially speaking, for many years, until at one time it threatened to repeat the history of the River Nile, which is cut off, you know, from the sea for vessels of more than fifty or sixty tons burden. This neglect is surprising in view of the fact that our leading statesmen have always recognized the ownership of the Mississippi river as a matter of commanding importance. First among these statesmen was the great father of Democracy, Thos. Jefferson, who, always a strict constructionist, thought he had violated the letter and spirit of the constitution when he finally consummated the Louisiana purchase. He justified the act on the plea of necessity, relying on the good sense and patriotism of the nation to ratify and approve it.

We find Benjamin Franklin also, as far back as 1784, expressing himself on this subject in a letter to Mr. Jay in the very strongest terms. He said, in substance:

"I would rather agree with the Spaniards to buy at a great price the whole of their rights on the Mississippi, than to sell a drop of its waters. *A neighbor might as well ask me to sell my street door.*"

And yet, after a supreme and successful effort to acquire this indispensable outlet to the sea, the government has seemed content with the mere fact of ownership, and for many years showed little or no inclination to enhance its benefits, or improve its usefulness.

In saying that the mouth of the river has been neglected, I do not mean to suggest that Congress has been altogether unmindful of the situation. The Eads jetties would be enough to gainsay such allegation. But the jetties are inadequate, and the ever increasing commerce of the valley demands a depth of water sufficient for the largest seagoing vessels, and nothing less than that will satisfy the just demands of its people. (Applause.)

I believe, gentlemen, I have now given a brief resume of all the matters demanding your attention, save, perhaps, one or two. One is the important

CANAL WHICH IS TO UNITE THE GREAT LAKES OF THE NORTHWEST WITH THE MISSISSIPPI RIVER.

This is a work in every way worthy of your support. I am not forgetful of the fact that the rival cities of Chicago and St. Louis have not agreed altogether about the construction of this important artificial water-way. But I am told that their disagreement on this and cognate subjects is, perhaps, a thing of the past, and judging from present indications, I take it that peace now reigns supreme. I shall hope, therefore, that it will be the pleasure of this august Convention to adopt a strong resolution in favor of this canal. (Applause.)

It may not be improper to say in this connection that we have always found the able Congressman from Chicago ready and willing to assist the people of the Lower Valley, and those who are so willing to help others should, on all proper occasions, receive cordial support in turn.

There is one other work of vast importance to the whole country that should have the benefit, I submit, of your utmost influence and most cordial approval. I speak of

THE ISTHMIAN CANAL.

Always a convenience, it is now a necessity. Its construction will bring us in closer touch with our recently acquired possessions in the far distant East. There the Stars and Stripes now proudly floating under an Oriental sun, will never be lowered, gentlemen, in my opinion, so long as time shall last. (Applause.) They tell the nations of the world in no uncertain tones that the mighty republic of the West has entered on a new era, not of conquest, but of usefulness, and that she is ready to meet, and ready to solve, all the responsibilities of the new environment. These late events proclaim

AMERICA A WORLD POWER,

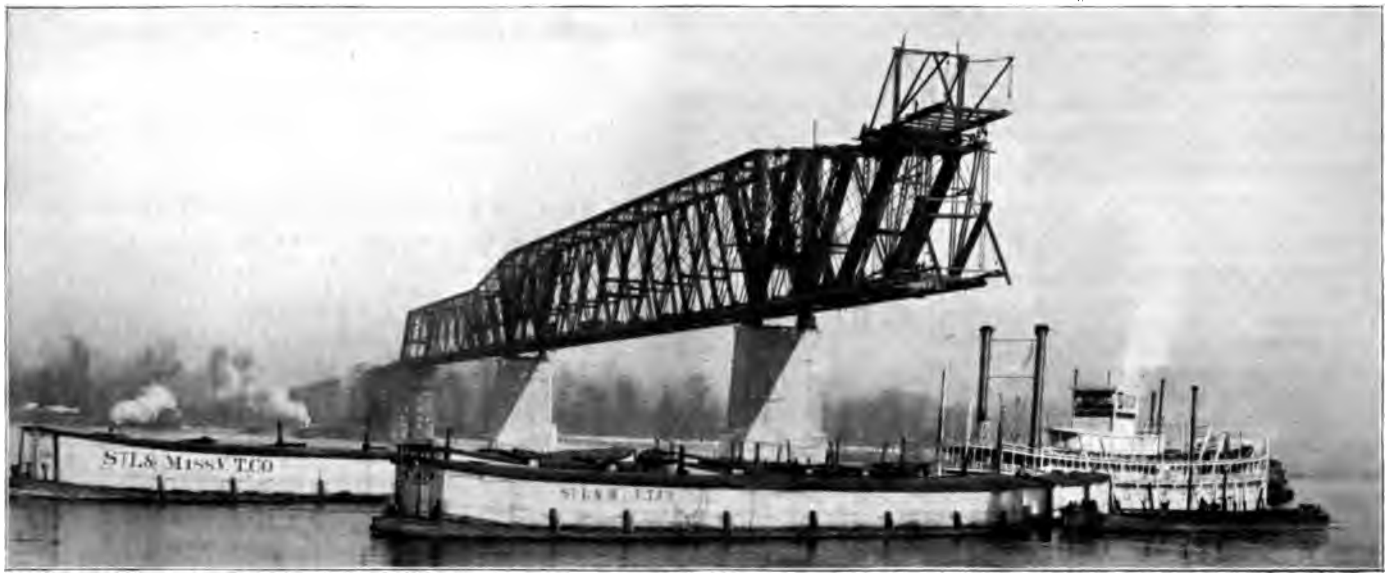
responsible alone to herself, her conscience, and her God, as to how that power will be used. (Applause.)

If the great Massachusetts Senator, Daniel Webster, could now return to the scene of his many earthly triumphs, he might well say of his own country, as he once said of England:

"Our morning drum beat, following the sun and keeping company with the fleeting hours, will circle the world with one continuous and uninterrupted strain of the martial music of America." (Great applause.)

Destiny, my fellow-countrymen, has appointed us to this task. We are simply repaying a debt of long standing. The Old World, centuries ago, sent out to the New her bravest and her best; the devout pilgrim to the bleak shores of New England; the gay cavalier to Maryland and Virginia; the brave Huguenot to the coasts of the Carolinas; to bring hither new life and all the blessings of civilization. Their descendants now repay the debt by infusing new blood into the stagnant veins of the distant East, for the mutual advantage of both nations, and the general welfare of all mankind. (Applause.)

But, my fellow-citizens, I am detaining you too long. I desire to express my profound thanks for the great honor you have conferred in making me your Chairman, and I now await the further pleasure of the Convention. (Prolonged applause.)



STEAMER H. M. HOXIE AND SIX LOADED BARGES,
PASSING MEMPHIS BRIDGE, THEN IN COURSE OF CONSTRUCTION, FEB. 17, 1892.

HIGH-WATER PROTECTION METHODS ON LOWER MISSISSIPPI RIVER

BY CAPT. WILLIAM JOSEPH HARDEE, CITY ENGINEER OF NEW ORLEANS

The preservation of the levee line on the lower Mississippi river during periods of high water is a most important subject and is worthy of much thought and attention to avoid the numerous and costly mistakes which have been made in the past. When the method under which that character of work was done during past years is considered, it is most surprising that so much success was achieved and that the mistakes which were made did not prove more extensive both as to cost and disaster.

Up to the present time there has been no well-defined organization for the systematic conduct of high-water protection work. The nearest approach to anything like systematic, intelligent and harmonious co-operation on the part of those engaged in such work was during the flood of 1897; but this was far from satisfactory and is susceptible of great improvement.

The absence of anything like system will be readily appreciated when it is remembered that there are engaged in the work some six practically independent agencies—the district levee board, the Parish officials, the State officials, the United States officials, the railroad officials and the individual planter. At the present time not one of those agencies has the available resources with which, alone and unassisted, to care for the levee line during an extraordinary flood.

The local district levee boards are charged by law with the responsibility of preserving at all times the integrity of their respective levee lines; and, except in a few instances, this charge has been intelligently executed; but there have been occasions when the task has vastly exceeded the resources of the several boards.

If those boards had possessed ample means, they would to-day have the levee line of their respective districts in condition to resist successfully the biggest flood so far experienced without the necessity for an amount of work in excess of their means. But they have not possessed adequate means to accomplish this end, and it is a fact that while the levees have been steadily improved, the floods of the past have found them in an imperfect condition, and a great amount of work of an emergency character has been necessary to successfully preserve them during high-water periods. On such occasions the other agencies have been requested to assist, or they have voluntarily proffered assistance by reason of their indirect connection with the cause and their general interest in the work.

It is a strange fact that each of the other five agencies, when rendering assistance, seemed to claim superior wisdom, and usually insisted, not infrequently to the disadvantage of the work, on proceeding according to its individual judgment. Confusion was the inevitable result, and from confusion sprung wastefulness and insubstantial work, sometimes accompanied by disaster.

Confusion, attended by wastefulness and insubstantial work, has oftentimes been due to a lack of forethought or proper advance consideration. In some instances expensive arrangements were made and large quantities of perishable materials were provided for prospective high-water protection work which never materialized. On other occasions the magnitude of a flood was neither anticipated nor appreciated until, figuratively speaking, the last minute, and then the necessary work had to be done hurriedly and frequently under the adverse conditions of bad weather, resulting in increased cost and less stability.

Based on his observations and experience, the writer believes that, with the resources at command, a system for economically and efficiently preserving the levee line during flood periods can be devised.

It is not considered advisable, however, to advocate a system which would involve the combined resources and efforts of the entire six agencies referred to, because, depending on time and circumstances, the resources of those agencies vary. A more practical system would be such a one as would involve one agency only, with adequate means prosecuting it, and then, as occasion would demand, the necessary work may in advance be divided and certain functions allotted to the different agencies according to the practicability of applying the resources of each.

The old maxim, "In time of peace prepare for war," applies with equal force to the preservation of levees. If it were practicable to do so, the levee line should, during low-water period, be put in such a condition that the usual cases of emergency which now arise would be in great part, if not altogether, removed. It is hoped that, with advancing years and the continued expenditure of large sums of money, this happy condition will be realized at no very distant date.

But, taking the levee line as it stands to-day, there are certain kinds of high-water protection work, as will be more fully described later on, incidental to every flood in excess of a stage which puts 3 feet or more of water against a levee. The full extent of protection work is, of course, governed by the size and duration of the flood. If it were possible to anticipate the approximate size of a flood, a large amount of work could be more substantially done and at a minimum cost. As a matter of fact, a flood in the lower Mississippi river can be anticipated within reasonable limits, and far enough in advance of its realization to permit the deliberate execution of a large amount of preliminary protection work.

An approximate relationship exists between adjacent water gauges on the Mississippi river when the flood surface of that stream is not disturbed by crevasses or augmented by the waters from tributary streams. For instance, a certain maximum at Cairo will produce a certain maximum at Memphis, the next prominent gauge station below. A gauge, however, below a tributary stream, may be affected by a flood poured out of the tributary, but, as there is an approximate relationship between a gauge so affected and the next gauge below, comparisons may be successively carried on until the place is reached at which a forecast is desired. The great bulk of the water which produces a flood in the lower Mississippi river is derived from the Ohio river and the Mississippi river itself above Cairo. A flood out of any of the tributary streams—St. Francis, White, Arkansas, Yazoo or Red—does not materially add to the height of a flood in the Mississippi. The effect of a flood from any one of those streams is rather to prolong the passage of a coincident flood in the Mississippi than to increase its height. Of course, floods poured simultaneously out of all those streams or out of each stream at or about the time that the crest of a coincident flood wave in the Mississippi passed its mouth would materially increase the height of the flood in the latter stream. But the records since and including 1890 do not show that such a coincidence of floods has occurred. They show, however, that some only of the tributaries contributed more or less to the height and duration of the floods of 1890, 1892, 1893 and 1897. On the other hand, the Mississippi river may be abnormally depressed below the mouth of the Red river, as has sometimes occurred, on account of Red river being low and a large volume of Mississippi river water in consequence thereof being drawn off by the Atchafalaya river.

As the great floods emanate north of Cairo, that place can properly be considered the strategic point, and the Cairo gauge can be accepted as a fairly reliable index to what will follow on the lower Mississippi. A wave, such as we are concerned with, in so far as it bears on the subject-matter of this paper, occupies from ten to fourteen days in passing from Cairo to Vicksburg, so that we always have that much advance notice of what is coming. The tributaries, of course, should be closely observed, and proper allowance should be made for any influence they might exert.

It is the writer's opinion that no damage can befall any of the existing levees when there is less than 3 feet of water against them. But at about the 3-foot stage the pressure is sufficiently great to commence developing weaknesses due to faulty construction, unequal shrinking or leaks caused by burrowing animals. It, therefore, follows that unless a flood in excess of that 3-foot stage is experienced, there is no need for protection work of any kind; but, as soon as it is evident that the 3-foot or higher stage will be experienced, preparations for a high-water campaign should be immediately begun, and conducted as the conditions attending the expansion of the flood demand.

The battures or foreshores vary in elevation with respect to the high-water surface at different places along the river. The ground is usually higher near the edge of the bank than it is at the levee, so that a flood which covers the ground near the edge of the bank puts several feet of water against the levee. The water usually finds its way to a levee through depressions and drainage ditches, and, with few exceptions, is well against the levee before the entire foreshore is fully overtopped.

The following is the approximate height which will put 3 feet of water against a considerable length of the levee line in the vicinity of the respective gauges, though a foot or so less in height will put 3 feet of water against short lengths of levee: Vicksburg, 42 feet; St. Joseph, 38 feet; Natchez, 44 feet; Red River Landing, 42 feet; Bayou Sara, 37 feet; Baton Rouge, 34 feet; Plaquemine, 29 feet; Donaldsonville, 26 feet; College Point, 23 feet; Carrollton, 12 feet. The gauge at Fort Jackson is not included, as its elevation is so often influenced by wind and tide.

It is now in order to ascertain what height at Cairo culminates in 42 feet at Vicksburg and 42 feet at Red River Landing.

A comparison of fifteen gauge observations selected at random shows that for stages of 25 feet or less at Cairo the time consumed in the passage of the crest of a wave from Cairo to Vicksburg varies from four to eight days. But as we are interested only in stages which culminate in 42 feet at Vicksburg, a comparison of lower stages should be disregarded.

On account of the closure of St. Francis basin during recent years, flood waves which occurred prior to 1898, and which were in excess of bank full stage, should be disregarded, as they would prove misleading. A comparison of all the flood waves of consistent elevation, since and including the year 1894, shows that 42.7 feet at Cairo will culminate in 42 feet at Vicksburg, and that the time of passage varies from ten to fourteen days, a fair average being twelve days. These figures include an addition of height and prolonged time of passage due to augmentation by water from the St. Francis and White rivers, which is almost invariably coincident with a flood of the elevation we are discussing in the Mississippi river.

Storms which occur in the valley of the Ohio river usually originate west of there, and, in their passage, traverse the territory drained by the St. Francis and White rivers.

The probable maximum height which the gauge at Cairo will reach may be estimated with fair accuracy by considering the gauges at stations north of that place on the Ohio and Mississippi rivers and their tributaries, so that by a series of deductions it is possible to secure more than twelve days' notice of what is to be expected, as well as to forecast beyond the 42-foot stage at Vicksburg.

The records show that at the time of the year when the gauge at Vicksburg reaches 42 feet Red river and its tributaries are usually low, from which it may be safely inferred that 42 feet at Vicksburg cannot be expected to culminate in more than 39 feet at Red River Landing; the time of passage may be placed at two days though on an average it is a fraction less.

It must, therefore, be noted that high-water protection work of some kind will be necessary under the proposed system between Vicksburg and Bougere (lower terminal of the levee system of the lower Tensas district), before work of any kind will be necessary below Red River Landing.

Ordinarily,—i. e., when the Red river and its tributaries are low, as is usually the case—the gauge at Vicksburg must read 46 feet to produce 42 feet at Red River Landing.

Failure of levees usually results from one of the following seven causes:

1. Insufficient height, which permits the water to flow over the top of the levee, cutting it away.
2. Leakage due to faulty construction; to uneven shrinking or sinking, or to the operations of burrowing animals resulting in the formation of cracks or holes, which, under some conditions, rapidly enlarge as the water flows through them.
3. Sloughing, due principally to some defect in the body of the levee, which permits the water to percolate too freely through it, and which, being attended by defective drainage on the land side, results in the land slope becoming saturated and so softened that it will not stand.
4. Sinking, the result of the levee having been built on an unstable foundation, generally of a quicksand character, which, under the influence of excessive wetting and the pressure exerted by the weight of the embankment, is displaced and causes the embankment to subside into the cavity thus created.
5. Wave-wash, which, when the river is made rough by wind or by passing steamers, attacks the surface of the levee not protected by a close growth of grass.

6. Excessive erosion at salient angles due to removal of all of the old levee, causing abnormal velocity of the current, which washes and cuts away the controlling embankment.

7. Cutting due to operations of malicious or insane persons.

INSUFFICIENT HEIGHT

Earthen embankments, no matter how well protected by a growth of sod, will be destroyed by water flowing over their tops for any considerable length of time. It is, therefore, absolutely necessary to keep the top of the levee well above the water surface. To assure this, the levee line should, if practicable, be maintained at a uniform grade, even if the cross-section of the embankment cannot at the same time be given the standard dimensions of 8 feet crown and 6 feet of base to each foot of height. All of the low lengths of the levee line should be brought to the standard grade well in advance of high water. The work can be done then not only at much less cost, but so much more substantially, and the cost of protecting the new work with washboards will be saved. This matter was seriously considered just after the flood of 1897, but, owing to the long length of low levee line, and the limited amount of money available for levee improvement, nothing much was done beyond a length of about five continuous miles by the United States in the Lower Tensas District and a few miles by the Atchafalaya board scattered throughout its district.

The length of low levee has since then been greatly reduced; it is believed that it is now practicable to raise all of the remaining lengths of low levee to standard grade during the coming construction season. But if this is not done before a flood is in sight which will overtop the low lengths of levee, as soon as a conclusion as to the probable height is reached, which should be as far in advance as possible, the topping or "capping," as it is commonly designated, should be put on with teams and scrapers. Work done in this manner generally costs less and has the advantage of greater compaction and is in consequence much more substantial than earth placed by handbarrows or wheelbarrows. To postpone the capping until the water is near, or actually on, the crown of the levee, or until the land in the rear becomes submerged by seepage or rainwater due to defective drainage, is taking an unjustifiable risk, and entails an avoidable increase in the cost of the work.

Whether the capping be put on by teams or by other means, it should be protected with washboards against erosion by the waves. In the past capping has been protected by sacks filled with earth or cotton-bale bagging carefully placed along the front surface of the capping. This method should be abandoned; it is more costly and less substantial than wooden washboards. If the capping is put on by teams, the washboards can be most advantageously placed after the earth is in place; but if the capping is put on with wheelbarrows or handbarrows, the washboards should be put on in advance of the earth.

The washboards should consist of 1 x 12-inch x 12-foot lumber placed parallel to the levee, standing on the 1-inch side and about one foot from the river edge of the crown. The washboards should be held in position by two lines of 2 x 2-inch pickets sharpened and vertically driven at least 15 inches in the levee; two pickets should be driven for every six lineal feet of washboards, one on each side of the boards and with just space enough between to permit the comfortable adjustment of the boards. Each board should be nailed at top and bottom to each picket. The writer has personally directed the placing of many miles of washboards, and has seen much of that kind of work done by others. Sometimes on account of scarcity of materials, or in an endeavor to economize on cost, single pickets only were placed, or double pickets at the junction of boards only, with a single picket at the half-way point between, and the boards were sparsely nailed or the nailing was altogether omitted. These latter methods are falsely economical and should not be practiced. The greater security obtained by the use of double pickets and full nailing will amply compensate for the cost of the additional materials.

Weakness in some of the capping which has been placed in the past has resulted from inattention to small details. In the first place, the portion of the crown of the levee to be occupied by the capping should be thoroughly broken up so as to make a good bond with the new earth. Without such bond there will be free leakage across the line of junction, particularly in the case of thickly sod-grown embankment. Care must be taken to see that each bottom board touches the levee throughout its length and that it is well pressed into the levee to prevent any under wash; the washboards should otherwise be firmly and securely set, for they are often and for long periods subjected to heavy strains by the waves beating against them, and if not made secure they will work loose. As soon as they get loose and are weakened by the waves they cause the earth behind them to loosen and crumble and wash under the bottom boards, and soon the entire capping is destroyed. Care should be taken to tamp the earth in light layers as it is placed against the washboards, to insure a close union of the two. Otherwise rainwater and over wave-wash water will percolate through the soft earth, impair the union and ultimately weaken, if not wholly destroy, the capping.. The top of the capping should be sloped towards the rear from where it joins the washboards, so that both rainwater and over-wash will promptly run off.

LEAKAGE

Leakage is due to either faulty construction, unequal shrinking or sinking, or burrowing animals, and constitutes one of the most perplexing problems a levee engineer has to deal with during high water. Leaks are more or less treacherous, and are both difficult and expensive to stop.

Failure to properly clean and then break up with a plow, or otherwise, the surface of the ground to be occupied by the base of the levee, to insure a perfect bond between the embankment soil and the natural soil; or failure before construction commences to remove all foreign substances which might in after years decay and leave a cavity; or the introduction of foreign substances into the embankment at the time of its construction may result in leaks.

In some instances, where old levees have been razed in building new levees or where they have caved into the river, the writer has observed in the body of the embankment, large cavities, which could have been produced only by the rotting of a wooden barrel or wooden box or a pile of logs. He has also observed a clear line of demarcation between the embankment soil and the natural soil, indicated by a stratum, two inches or more thick, of partially decayed leaves and trash. This stratum must, by reason of its composition, be permeable, in which case leakage would be free, and, after the trash and leaves would be deposed, the soil of the embankment or the soil of the ground would be attacked and eroded in proportion to the strength of the flow of water through the channel thus created.

There need be but little apprehension in the future from leaks originating in the several manners described. During the past ten years a large percentage of the levee line of the Fourth Engineer District, Improving Mississippi river, has been built anew, and the remaining lengths have been so substantially enlarged as to almost entirely eliminate original defects; the system of inspection has been rigid, and it is not probable that the embankments contain any defects of construction.

Unequal shrinkage cannot easily be provided against. It usually manifests itself in cracks extending in almost every conceivable direction, and its occurrence is most frequent in embankments built of buckshot or clayey materials or in embankments built of those materials and sand, alternately placed in thick bodies or layers. The degree of inequality of the shrinkage seems to be governed entirely by the amount of moisture in the soil when it is put into place.

The earth near the bottom, sides and top of a crack, usually expands when moistened. If it is wetted by slow degrees the crack will usually close up. The greatest danger attending a crack occurs when the soil surrounding it remains unwetted for several years during which time the crack increases in size, and, if a large volume of water be suddenly thrust upon it, the soil will rapidly wash and the crack increase in size until it finally causes the embankment to collapse. Unequal shrinking is rare in embankments built wholly of loam or sand.

The levees should be carefully inspected just before or soon after the water has gotten against them, and, if cracks are found they should be filled and rammed with loose earth, particularly and most carefully on the intake side. If a crack is not discovered until the water is well against the embankment, the exposed portion should be treated as above, and clods, mixed with loose earth, should be dumped into the water over the crack until the flow of water has been entirely cut off.

Lateral cracks in a levee are sometimes caused by the sinking of a section of embankment built on a bad foundation, while the adjoining section, built on a good foundation, stands firm. Such cracks are usually large and conspicuous, and should be repaired during low water. If not repaired then, they should be treated exactly as has been described for cracks produced by unequal shrinkage.

The attention which has been devoted to draining old burrow pits, neighboring sloughs, etc., has resulted in a large reduction of the nocuous operations of burrowing animals, by destroying their harbor and breeding places, causing them to migrate to localities more favorable to their pursuits. But the evil still exists to a troublesome degree. Burrowing animals do not work with great success in sandy soils because the walls cave in behind them; it is in clay that they do their best work. For that reason we find few levees built of sandy soils cut up with leaks made by burrowing animals. This kind of leak is mostly found in buckshot or clay levees; a compensating advantage exists in the fact that such soil does not easily erode and a single hole is not always dangerous. If it is no larger than two inches in diameter it will do no damage as long as its size does not increase. It should be carefully watched, and, as long as the water it discharges is clear or free of sediment, all is well. But if it discharges muddy water or a considerable quantity of sediment, such action is plain evidence that the hole is either a very direct one or that it is enlarging by erosion, or that an animal or animals are somewhere at work in it. It has then become a menace to the safety of the levee and should be promptly treated.

The greatest danger to be apprehended from holes through any kind of a levee is the presence of a large number of them within a small area. As the holes enlarge, the intervening volume of earth is correspondingly reduced; individual enlargement results in several holes working into each other and becoming one hole, and this process of conversion, if not checked, may continue until numerous small holes have become one large hole beyond control.

Plugging a hole is rather a simple matter if the intake end of the hole can be located, but to stop a good-sized leak at the discharge end is tedious, expensive and uncertain. The intake end of a hole which discharges out of the land slope of the levee, or at the base of the levee, or just beyond the base of the levee, may be several hundred feet distant from a point immediately abreast of it on the river side, or, if approximately abreast of it, a hundred feet or more distant from the base of the levee. There being a well-defined channel affording a line of least resistance, the water flows along that line. But as soon as the discharge end is obstructed another line of least resistance develops, probably a minute channel connected with the main channel, which, under the increased pressure, rapidly enlarges and the water bursts out elsewhere. The flow continues as before, not infrequently to a greater extent if the flow line has been made more direct.

The writer has determined the location of the intake end of a hole by the use of unslacked lime. This method is very tedious, and is not practicable if a large area must be investigated. If unslacked lime be dropped into the water just over the intake and is sucked into the hole, that fact will very shortly be manifested by the water discharged by the hole. In order not to confuse the location of the intake, small areas of ground only can be covered at a time.

The use of lime is valuable in some instances, and is recommended to determine if the hole be direct; that is, if its intake end is immediately abreast of the discharge end and within reasonable working distance from the base of the levee. The position of the intake end of a hole largely governs the method which should be employed to stop the leak. In the majority of cases the intake end of a single hole is so far removed from the discharge end that it is impossible to locate it. When numerous holes exist within a small space the intakes are nearly always just abreast of the discharge ends.

It is not considered possible to define a method for universal application in stopping leaks. Nearly all leaks have to be cared for according to their individual characters, and this can come to him in charge only by long experience. The experienced physician does not always need a thermometer and pulse test to determine that a patient has fever; something almost intangible, in the appearance of the patient, the odor of the room and other things, make the fact apparent to him. So it generally is with the experienced levee engineer; he seems to know intuitively whether a hole is dangerous, as well as how it should be cared for. However, some general rules apply to the stoppage of leaks, particularly to the avoidance of expensive and worthless work, which may augment rather than reduce the danger.

A common method for stopping leaks, when the tools and materials are available, is to drive with a dolly, or light hand pile driver, a single line of sheet piling (2 x 12-inch boards tongued and grooved or otherwise prepared to make close joint) into the river slope of the levee or into the ground, just at or immediately beyond the base of the levee to a sufficient depth to encounter the hole or holes, and thus cut off the flow of water. This is a certain and comparatively inexpensive remedy if the holes can be encountered, but if the holes are not covered the work is worthless and its cost will have been wasted. Sheet piling should therefore not be employed when the river side position of the hole cannot be definitely located.

As dollies have not been extensively used along the river, a brief description of them is pertinent. A dolly is a stick of square or rectangular shaped timber of varying size and length, according to the driving power desired, near to the outer end of which, at proper working distances apart, are nailed cross-strips or hand-boards to furnish convenient grasp for raising it. The inner end rests on the ground or a platform, and is held in position by several stakes or pegs driven about it, the ground end being but slightly lower than the outer end to maintain the dolly on something like a horizontal plane. Enough men are put at the hand-boards to readily raise the outer end of the stick several feet above the object to be driven. The stick is raised and sharply let fall alternately until the object is driven to the desired depth. Great care should be observed in selecting the position for the sheet piling with reference to the location of the leak or leaks and the character of the soil composing the embankment. The very least possible penetration by the sheet piling is desirable, to reduce vibration and avoid weakening the embankment by cracking or loosening it. In dealing with soils which easily crack or loosen when penetrated, the sheet piling should never be driven into the body of the embankment. Sheet piling should also be driven in the shortest possible time.

During the flood of 1892 a crevasse was caused by inexperienced men driving sheet piling into the embankment at Tessier's Plantation, Pontchartrain District. There were three 3-inch holes in the levee at that place, discharging within a few feet of each other at the land base of the levee. These holes had existed for some years, and had been frequently observed. In those days many such leaks existed at numerous places in that levee district; a few only of them were considered to seriously menace the safety of the levee, and those few were cut out when the river was low. But the great majority were allowed to remain undisturbed. Just before the flood reached its maximum stage, some of the leaks which had been allowed to continue showed serious symptoms, and the Levee Board decided to stop all of them. In this task a number of the bridge gangs of the Yazoo and Mississippi Valley Railroad were employed. A small gang of men, without experienced direction, commenced work during the afternoon driving sheet piling into the river slope of the embankment at Tessier. Mr. J. W. Ross, a nearby resident and ex-member of the levee board, has since told me that he was present a part of the afternoon the sheet piling was being driven; that before any of the piling was driven the holes were discharging clear water, free of sediment, and that the holes gave no evidence that enlargement was in progress; but that after a few planks had been driven the holes commenced to discharge muddy water and large quantities of sediment. There was no relief gang, and work was discontinued at nightfall, at which time some six or eight piecs of plank had been driven. At about nine o'clock that night the levee collapsed, and the river poured through the opening. There is scarcely a doubt that the piling cracked and loosened the earth in the embankment, causing it to erode rapidly, and that the sheet piling was the direct cause of the failure of the levee.

Another, but more costly method for stopping leaks having their intake ends on the front slope of the levee or within reasonable working distance of the base of the levee, is to drive vertically two lines of 1x12-inch boards, not necessarily arranged to make close joints, from 3 to 6 feet apart, (distance regulated by height of structure) with just enough penetration to furnish good toe hold, sufficiently braced longitudinally and laterally to afford required rigidity. This structure is built in a continuous length from the levee to a point beyond the intakes and back to the levee, and, after the woodwork has been completed, the interior formed by the two lines of plank is filled with earth. The structure is commonly called a mud-box. Sometimes, owing to scarcity of materials or to inexperience of those doing the work, a single line of 1-inch plank was driven, and the entire space between it and the levee was filled with loose earth or sacks filled with earth. This form of structure is called a bulkhead. It is manifest that either bulkheads or mud-boxes, like sheet piling, are worthless unless the sore itself—the intake end of the hole—is reached and covered. The writer has seen a large amount of all three of the kinds of work described which failed to accomplish any good.

Of the three methods named, sheet piling, when practicable, is recommended. It is equally effective, less expensive and most quickly put in place.

When a hole develops serious symptoms and its intake end cannot be located, it must be treated in the most substantial manner possible at the discharge end.

During the flood of 1890 the writer experimented with light sheet iron cylinders of different lengths, having a diameter varying from 10 to 18 inches; they were equipped with soldered handles at intervals to afford good hand hold. To reinforce the cylinders at the base about ten cubic yards of earth was piled in conical shape about the hole, a small drain being left temporarily to take off the water flowing through the hole in the levee. As soon as the earth was in place the iron cylinder was clapped over the hole and forced into the ground by the weight of as many men as could get hand hold. The surrounding earth was simultaneously tamped about the cylinder. Not more than two out of a dozen of the cylinders proved successful; none of the large ones, over large holes, were successful. The water at first rose rapidly in the cylinders, but gradually diminished in rate until it stopped rising altogether. Generally the water found a line of less resistance, and broke out through the ground only a few feet away.

The common method of treating a leak at its discharged end is by building what is locally termed a "horsehoe," which is nothing more than a mud-box, such as has been already described, built on the land side of the levee, and of such length as may be necessary to leave a good margin of ground on all sides of the leak. While it is expensive, this method is certain in its results if the levee is not too largely infested with leaks, and is recommended in cases of serious leaks when the intake end cannot be definitely located. In the past, when lumber was not available and sacks were at hand, "horseshoes" were constructed by pyramiding sacks filled with earth. Such a structure is unnecessarily expensive, and should be discountenanced.

During some of the past floods the writer has known short lengths of levee to be so infested with leaks that application of all the several remedial measures, which have been mentioned, did not assure the safety of the levee. In such cases collapse was anticipated, and, to provide against disaster, several lines of cribs (the number of lines being regulated by the depth of the water in which the structure was placed) were built and filled with sacks filled with earth. In other words, the crevasse was closed before it occurred. The cribs were so placed as to extend well beyond the base of the levee and at both ends to join sound embankment.

These very bad places were the result of neglect; of failure, when the river was low, to cut out leaks which were known to exist but which were allowed year by year to extend and enlarge until the levee became thoroughly rotten and scarcely more water-tight than a sieve.

The improved condition of the levee line and the attention which is now usually devoted annually to repairs and maintenance warrant the belief that such extreme cases of bad levee, as have just been described, are things of the past.

The treatment of leaks should in the future be more simple and at the same time, less expensive than in the past. To-day much more is known of their character and how to deal with them; and the best remedy only of the past should be applied until some more successfully remedy is evolved. It is contemplated, of course, that none but experienced men will direct the work, and that suitable materials with which to do the work properly and economically will at all times be at hand.

The foregoing remarks refer to leaks of an ordinary character, but as very extraordinary leaks sometimes occur, it is thought advisable to describe one that came within the writer's experience and how it was treated, as under similar circumstances the same treatment would seem to be best and should be applied. The following is quoted from my report of the 1897 flood:

"During the morning of April 27, when the water was at 52 on the Vicksburg gauge, a large leak developed under the Clagget levee (644-R). At this place both the levee and surrounding soil are light loam. In the rear of the levee within 30 feet of its base there is an old burrow pit about 8 feet deep with almost vertical side next to the levee. Without previous warning a 6-inch stream of water spurted out of the wall of the pit midway its height; it did not merely run out and trickle down, but shot out as if ejected from a hose. Its force was so great as to churn the water into foam in the pit into which it was discharged. There are many theories as to the origin of this leak, but its cause will never be known unless the embankment should be cut and the hole traced.

"It is more than likely a series of disconnected holes or small cavities existing under the levee, due either to burrowing animals or decayed vegetation, or probably both, and under the pressure of water there was leakage from one to another, attended with a certain amount of wash which continued until the several holes were connected and made a free passage for the water through one large channel where the water burst out as described.

"A large force was immediately summoned, and a semicircular wall of sacks built about 6 feet high around the discharge end. The interior space rapidly filled, and the sacks were soon overtopped. In the meantime a large force of teams was put to work, and a run around commenced about 100 feet in rear of the main levee and designed to be about 250 feet long when completed. An opening was left in it as an outlet for the overflow until the new embankment was thought sufficiently high with proper cross-section to hold the filled basin, then the opening was closed. The basin filled rapidly at first, then more slowly; at the end of two days it was found that the basin was still filling, and would overtop the run around. The teams resumed work, and the embankment was raised 3 feet. The basin continued to fill, but as the river commenced falling in a few days, further raising was not necessary. It now stands with an 8-foot crown, about 2 to 1-inch side slopes, and a grade about 3 feet lower than the highest point reached by the river."

SLOUGHING

When water has stood against an earthen embankment for a sufficient time to saturate it, there is always considerable seepage caused by the river water percolating through the pores or interstices of the embankment. The amount of seepage is usually governed by the porosity of the soil composing the embankment. Seepage is not usually free in embankments composed of clayey materials; when seepage does seem to exist in them to a considerable extent, it is more properly leakage due to cracks in the embankment caused by contraction in drying out or to unequal shrinkage. Seepage is freest in embankments composed of sandy soils; the coarser the grain of sand the freer the seepage, because the soil does not become sufficiently compacted during the time the embankment is constructing to render the mass impervious to water. Voids are of large or small size, depending on the coarseness of the grains of sand. Under water pressure the voids soon become connected and form numerous minute channels, which wash and enlarge as the flood is prolonged or the pressure increased by greater height.

Seepage produces a general softening or rotting of the land slope of the embankment. The soil at this point often becomes semi-fluid, and, if the slope be steep, a part of the embankment will slough or slide out, producing a corresponding loss of cross-section. The writer has never known a first slough to extend higher up than one-half of the slope of the levee. If the seepage be not stopped, a second slough will occur higher up as soon as the face made by the first slough has been reduced to a semi-fluid condition; this action will progress in steps until the embankment has sloughed across its entire cross-section as far as the water. Its action being progressive, sloughing does not constitute an element of great danger, for there is always ample time to stop it; treatment is simple if the principles involved be understood.

To arrest sloughing, good land-side drainage and stoppage of the seepage are essential. A competent drain ditch should be cut, about 2 feet clear of the base of the levee, to conduct the seepage water as frequently as possible to some natural line of drainage in the rear of the levee. Additionally, numerous small V-shaped gullies, an inch or so only wide and deep should be cut in the land slope of the levee to promptly deliver the seepage water to the drain ditch. The position and size of the drain ditch and gullies should be such as to assure the removal of the seepage water as fast as it comes through the embankment, for if this water is allowed to stand, the land slope will not become water-soaked and its integrity will be preserved.

The next step is to stop the seepage; this is effected by dumping loose earth into the water in sufficient quantity to cover the submerged front slope with a blanket of fresh soil several inches thick, the coarser particles of which will be sucked into the interstices or small channels. These soon expand from wetting, and shortly the seepage will be "choked." The layman who sees this work in progress will immediately classify dumping loose earth in the water as sheer nonsense, but, as a matter of fact, the good effect will manifest itself in a short while after work has been commenced; at first by reduced seepage, a little later by entire stoppage and ultimately by the mass drying out and showing no further inclination to move.

If sloughs be treated when they first occur, or, better still, before they occur, when their approaching occurrence is clearly indicated to the experienced eye by the presence of excessive moisture on the land slope, much annoyance and expense can be avoided. As the treatment of sloughs is necessarily expensive when a number occur in close proximity and the supply of labor is limited, they may be only partially instead of wholly treated; that is, in lieu of putting a large enough blanket of loose earth on the river slope of the levee to provide against further seepage during the entire flood period. Only a small blanket need be put on, just enough to stop the seepage for a few days. The wheeling runs should be left in position, and, as soon as seepage again manifests itself, work should be resumed until the flow is once more stopped. In this way a force of fifteen to twenty men may be kept nearly constantly employed working from slough to slough.

It is usually the case, when a slough occurs and an inexperienced man tries to correct it, that he will endeavor to restore the lost cross-section with earth or sacks. This does no good, but rather tends to augment the trouble, because the slough is thereby rendered more difficult to drain, and at the same time that much more weight is put on the semi-fluid mass to squash it out, which invariably pulls with it some of the remaining good embankment. He does this because he does not understand what produces the slough. He does not know that it is caused by too free leakage through the embankment and inefficient land-side drainage.

The writer received his first lesson in treating sloughs by observing men at work about a fleet of coal barges. If a barge starts a seam leak, it is impracticable to dig away the coal to get at it. It is equally impracticable to detect the leak by feeling along the outer or water side of the barge, as the inflow is too light to be detected by the hand, and then, again, as a loaded barge draws from 8 to 9 feet of water, it would oftentimes be impossible to reach the leak by hand. But the coal barge man has a supply of coarse sawdust, and by means of a long handle, to which it is attached, lowers a cup of sawdust in the water within close proximity to the leak, shakes it gently, just next to the barge, and, as the sawdust floats out of the cup, some of it is drawn into the crack and becomes lodged; it very shortly gets wet and swells, and the leak is choked. The same principle applies to stopping sloughs.

SINKING

Sinking embankment is treacherous and requires the most careful attention and the exercise of good judgment in its treatment to prevent disaster. It is treacherous because its action is sudden and not always attended with premonitory signs, and good judgment must be exercised in treating it, lest the remedial measures prove destructive. A troublesome feature which attends the care of a sinking levee is that it is invariably situated in an ill-drained swamp, which soon fills up with seepage or rainwater, and earth with which to repair it is not immediately accessible, having generally to be transported a long distance on barges. At the present time there are only two lengths of sinking levee in the Fourth District. One of them, which covers about 2,000 lineal feet, is at Kempe in the Lower Tensas District, and the other, which is a small affair, about 50 feet long, is at Point Manoir in the Atchafalaya District.

Several sinking levees, of greater lengths and attended by subsidence of greater extent than the two levees just named, have been experienced in the past, but after much work they were made secure. The most aggravated cases of sinking seem to have a limit of subsidence, and it is only a question of continuing to pile on earth to secure a substantial embankment. The levees at Kempe and at Point Manoir should therefore be made secure in time.

A levee sinks because it is built on a foundation composed of quicksand or some other equally soft or semi-liquid material, the power of which to sustain weight is governed by the degree of moisture contained at the time the weight of the embankment is put on. It has sometimes occurred that the sustaining power has, during construction, been sufficient to support the embankment, and no movement has taken place until some later date, when the strength of the foundation has become impaired by being excessively wetted.

It has been the general experience, however, that all aggravated cases of sinking levee have been attended by considerable subsidence during construction.

As the weight of the embankment is the direct cause of the sinking, care must be observed not to add, during a flood, more earth than is actually necessary to hold the water. As the embankment subsides, the very lightest possible addition should be made to maintain an elevation several feet above the water surface and the narrowest width of cross-section that will resist seepage. This will entail almost continuous work of small amount rather than a large amount at intervals. It must not be forgotten that if a large amount of earth should be added in a short space of time, the rate of sinking will be accelerated, and the addition will do more harm than good.

Sinking embankment seldom subsides uniformly. Parts of it sink faster than others, causing the levee to crack longitudinally. There is usually one large crack along the crown of the levee, though sometimes other but smaller parallel cracks occur. Care must be taken to keep the water excluded from all or as many of the cracks as possible, particularly the largest one. As soon as water enters a crack, hydrostatic pressure is exerted on the section of embankment in the rear of the crack, and the remaining embankment in front of the crack is rendered valueless as a factor of strength in resisting the pressure of the river. For this reason the addition which is made to keep the top of the levee above the water surface should be placed as far as practicable to the water side of the crack. Lateral cracks which would let the water into the longitudinal cracks must be guarded against and immediately stopped if any occur. If, as is somewhat common, there is seepage through a sinking embankment, prompt measures must be taken to remove the seepage water in the manner described for treating sloughs. As much depends upon keeping the levee dry, it is advisable to spread tarpaulins on the entire sinking levee or at least cover the large cracks while rain is falling, to prevent wetting and to exclude rainwater from the cracks.

A sinking levee may be compared to a sick baby, and requires the same continuous attention and care. As only a small margin of safety exists, a competent force, equipped with ample materials, should be retained at the levee night and day, prepared to care for emergencies at a moment's notice.

WAVE-WASH

Wave-wash is common on levees exposed to full wave action and not protected by a close growth of grass or some artificial device. It is a much overrated danger, and has been the cause of the needless expenditure of large sums of money in the past. Wave-wash is misleading in its appearance; in nearly every instance its worst feature is visible, but the inexperienced invariably conceive the idea that the vertical face made by the wash extends to the base of the levee and that the cross-section of the levee has been so much reduced as to seriously endanger the embankment. As a matter of fact the deposed soil settles into position just under the water surface and the reduction of the cross-section is no greater than is apparent above the water surface.

There was a time in the past when the cost of moving earth was comparatively high, and it was less expensive to prevent a part of the levee washing away than to allow it to wash away and afterwards replace it. But this condition no longer exists; under ruling prices for moving earth it is cheaper to restore wave-wash than to prevent it with revetment. Revetment should therefore not be resorted to until the safety of the levee is endangered, which, in the writer's opinion, is not until the crown itself has been attacked. It is accordingly recommended that no steps be taken to arrest wave-wash until the vertical face it cuts has reached the river edge of the crown of the embankment.

When revetment is used, as its service will be but temporary, the most inexpensive structure should be employed. Such a structure consists of posts 3x3 inches or 4x4 inches, driven into the river slope of the levee and inclining towards the levee at an angle of 15° to 20° from vertical; the upper end of these posts should be rendered immovable by 2x6-inch braces connecting them with a short piece 4x4 inches or 2x6 inches, called an "anchor," driven in the crown of the levee. The posts should be placed not more than 6 feet apart, to give the structure sufficient rigidity to resist the buffeting of the waves. To the outer face of the post must be nailed 1x12-inch boards, laid horizontally, care being taken to have the bottom board everywhere throughout its length rest firmly on the slope of the embankment to prevent under wash. It is not usually necessary to maintain the boarding higher than 2 feet above the water surface to provide against destructive overwash. If revetment be placed in the early stages of a flood, the posts should be made long enough to stand such additional plank as the rising river may afterwards necessitate.

EXCESSIVE EROSION AT SALIENT ANGLES

This is a danger which is not often encountered, and it may be easily provided against; its existence is directly due to the inexperience or inattention to duty of the constructing engineer.

Acute salient angles are rarely put in new levee lines; the most acute angles put in new levee lines are the re-entering angles. Acute salient angles in the controlling line of levee are usually found at the junction of a new levee with an old one. If such a junction occur behind a sharp point in the line of the river, it will be subjected to excessive velocity of the current. When the river is extraordinarily high, the distance across a point is so much shorter than the length of the channel around the point that the river pours across the point with increased velocity. This excessive flow should be restrained from exerting any influence on the controlling line of levee by leaving the old levee, which the new levee adjoins, undisturbed for several hundred feet from the junction. In building new levees it is a common practice to cut away the old levee, which may be nearby, to secure better building material and at the same time to reduce the length of haul. There is generally no objection to doing this, but in cases of salient angles, which, under the circumstances above related, would be exposed to excessive wash, the practice should be omitted.

If, however, a salient angle should be washing at a dangerous rate, the wash may be arrested by constructing a wing dam to check and divert the current. A suitable and inexpensive wing dam consists of a crib similar to that described under the head of "Leaks," built at an angle of about 45° to the axis of the flow on the upper side of the salient angle. The wing dam should be commenced at a point on the levee about 50 feet above the angle, and extended so far that its outer end reaches to or overlaps the salient.

CUTTING

Cutting a levee by malicious or insane persons can be prevented only by closely guarding the line while the water is near enough to its top to permit the work of cutting to be done in a short time. Remedial measures are of no avail; preventive measures alone must be employed.

EQUIPMENT AND ORGANIZATION

To execute most economically, as the exigencies of the situation demand, any of the various kinds of work which have been described, suitable tools and materials and ample labor under competent direction must be at hand. As has been stated, much waste has resulted in the past from the use of other than the materials best suited because the most suitable materials were not available, and from incompetent direction of the work. In protection work, as in other things, "a stitch in time saves nine." Much expense may often be avoided if a weakness be discovered in its incipiency and promptly corrected.

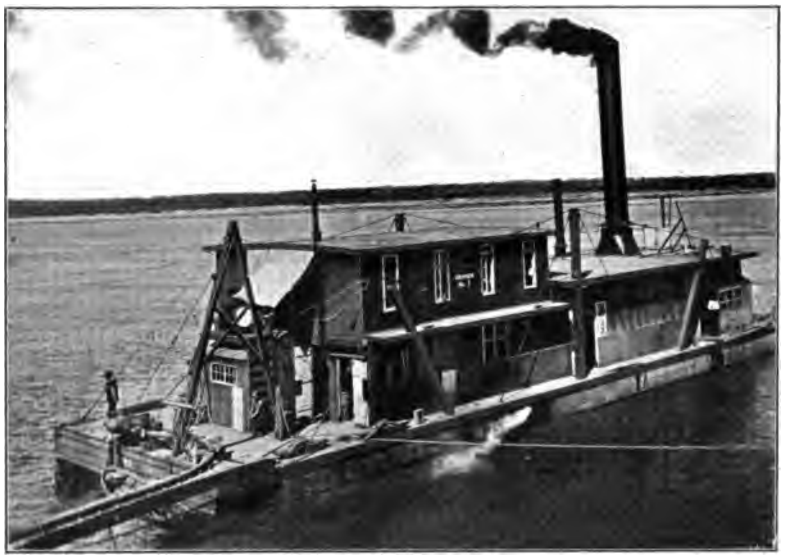
No high-water protection system can be complete without good transportation and good communication facilities. To make tools and materials readily available, supply depots should be established every five miles along the levee line, and these depots should be connected by telephone service.

Each of these depots should be provided with a house in which to store tools and materials and incidentally to furnish sleeping and eating quarters for watchmen and workmen; each depot should be equipped with two small flatboats to move tools and materials to points where they may be needed.

By the time the river has reached 42 feet at Vicksburg, and, later on, 42 feet at Red River Landing, there should be an inspector in the field having general supervision of the high-water work for about 135 miles of levee line. He should keep constantly moving over the line to instruct his assistants and to see that they properly discharge their duties; he should also keep himself informed as to the materials on hand as well as those which may be required.

Under his direction there should be inspectors having local supervision of the work on 20 miles of the levee line each. These men should inspect every foot of the levee line on their beat at least once in every twenty-four hours. As soon as they arrive on the ground, the embankment should be thoroughly cleared of all weeds and coarse vegetation, and the grass should be mowed close to the surface in order to fully expose the entire surface to the closest scrutiny. At the same time, existing drain ditches near the land base of the levee should be cleared and put in good order. If such ditches do not exist they should be promptly cut. As the river rises, or the amount of protection work increases, the 20-mile beat should be reduced to such a length that the inspector can inspect every foot of it daily, and otherwise give it proper attention and competently direct all necessary work.

Whenever the water in the river gets within 3 feet of the crown of the embankment, a reliable day and night watchman, in addition to the inspector, should be placed on every 2 1-2 miles of the levee line, and the watchmen should be required to constantly patrol their beat during the night as well as during the day. If dangerous places develop, no matter what the height of the river may be, a day and night watchman should be retained at each of such places in addition to the patrol watchman.



HYDRAULIC BANK GRADER.

H. S. DOUGLAS.

PROTECTION OF CAVING BANKS

BY H. S. DOUGLAS, ASSISTANT U. S. ENGINEER

The general objects in view or ends to be obtained in the improvement of the Mississippi river are: To improve navigation; and, to prevent disastrous overflows during floods.

At present the methods of attaining the first object are: The maintenance of lights or beacons to mark the channel for the guidance of pilots, the operation of snag-boats to remove obstructions, principally trees that cave into the river in the concave bends, and lodge in the channel; and the use of powerful hydraulic dredge of enormous capacity for dredging the shoals or bars that obstruct navigation during low water.

The second object is attained by the construction of levees or earthen embankments of a sufficient height and section to confine the waters when the river overflows its natural banks.

Both objects have been attained to a measurable extent, but much more remains to be accomplished before complete success, is not a matter of speculation but of certainty.

So long as the river can, by caving its banks, shift its channel from year to year, permanent improvement in the strict sense of the term is impossible. The caving of the banks changes the position of the channel and the lights and beacons must be constantly moved to suit the new conditions. The snag-boats find endless work in the removal of snags made by the trees that are undermined and fall into the river in the concave bends. Theoretically if there were no caving banks there would be but few bars to obstruct low water navigation, because the river being deprived of its principal supply of mud and sand would not build bars and shoals with the material it moves along in suspension. It would be practically a clear water stream and there would be but little work for the powerful dredges. A channel once made by them would be reasonably permanent.

A permanent levee system is constantly spoken of, but such a thing in a strict sense is impossible so long as the river, by caving away its banks, eats into and destroys many miles of expensive levees which have to be constantly replaced by new embankments built further back from the river. There are certain bends of the river where four, five and six lines of levee have been built in the past thirty years. The cost of building these new embankments is so great that it prevents to a considerable extent the improvement of the system at large. If it were possible to expend this money in the enlargement and strengthening of a permanent levee line it would be but a comparatively short time before the dreaded "crevasse" would be unknown and the stubborn, costly and frequently unsuccessful high water fight made on the levees during floods a thing of the past.

All of which goes to indicate that if the river can be prevented from caving its banks, the problem of its practical and permanent improvement and the attainment of all the objects sought is solved.

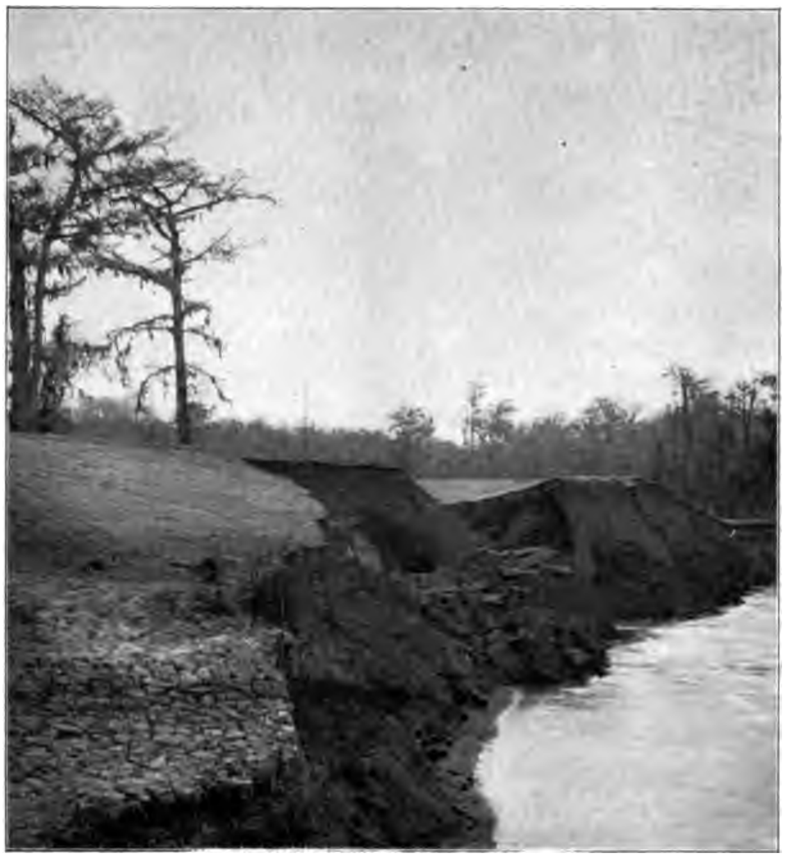
Unfortunately a cheap and successful method of protecting caving banks is yet to be discovered or invented. By the expenditure of large amounts of money a successful bank protection has been placed, but the cost has been about $180,000 per mile of protected bank. This practically prohibits bank protection at present unless the interests at stake are of great value as at Memphis, Vicksburg, New Orleans, etc. In the early days of river improvement it was thought that the banks could be held by light and comparatively inexpensive works, such as wire screens, pile dikes, and small light mattresses of willow brush woven basket fashion on poles. The constant failure of such works has necessitated the substitution of heavier and more expensive construction, until what is known now as the standard bank revetment consists of a heavy brush mattress from one to three feet in thickness and extending from low water mark 300 feet out into the channel of the river. Above low water mark the bank is graded to a slope of about 1 in 3 and paved with rock. This latter material is used to sink and hold the brush mattresses in place on the bottom. Revetments of this kind have been generally successful, but as already stated, are very expensive, not only in the actual cost of construction, but in the enormous plant required. Experiments of various kinds in the direction of reducing the cost of a successful bank revetment have been tried, but none of them have given results that promise complete success. What are termed "submerged sloping spur dikes" have given the best results, and in certain localities have proven successful. They are much less costly than the standard revetment, but are not adapted to all portions of the river.

To the casual observer who views a caving bend of the Mississippi river, all that seems necessary is to protect that portion of the bank which he sees. As a matter of fact what he sees is only the effect, the cause being concealed. That portion of the bank that is concealed from view below the surface of the water is eroded and scoured away by the current, and thus removes the foundation or support of the upper bank which caves and falls into the comparative void that has been prepared for it. The wide willow mattresses of the standard revetment that carpet the bank below low water are intended to prevent this scour of the subaqueous bank. It frequently happens, however, that before the mattress has been placed the scour has already occurred and the stability of the bank been destroyed. In such cases the mattress is wrecked by the subsequent caving of the bank on which it is laid. Such incidents do not indicate that this method of protecting caving banks is a failure, but merely that the work was not done at the proper time. There are many places on the lower Mississippi river where, if the water suddenly disappeared, the inhabitants of the immediate bank would find themselves dwelling on the brink of a cliff from 150 to 200 feet in height and approaching the perpendicular.

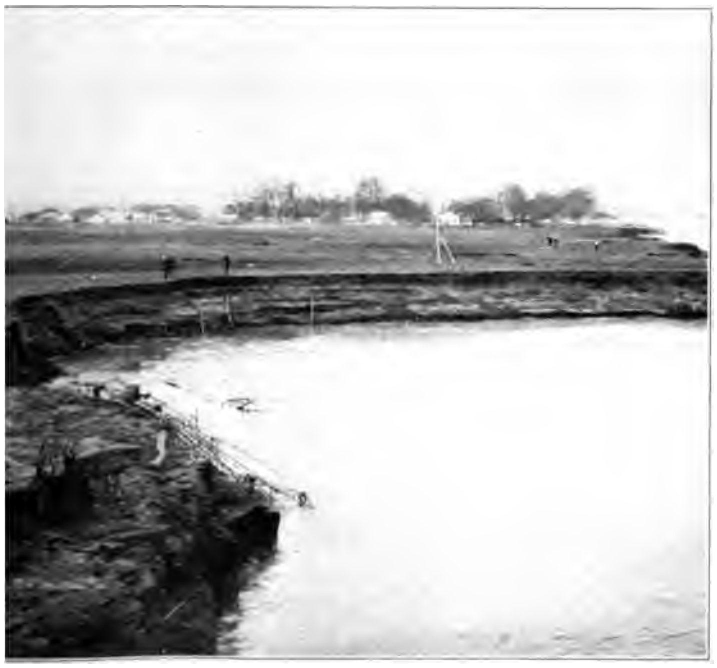
Among many plans suggested for the improvement of the river is that of making cut-offs across the narrow necks of the horse-shoe shaped bends. The idea is attractive, but perhaps no other plan has been suggested that would be so destructive to the permanent improvement of the river. Cut-offs would obviously shorten the river but the shortening would be temporary, as the current would be greatly accelerated and consequently the caving in the concave bends become more rapid until by the lengthening or deepening of these bends the river had regained in distance all that it lost by the cut-off. This fact will be readily recognized when it is considered that the distance from Cairo to New Orleans by river has not changed materially, notwithstanding the numerous cut-offs, both natural and artificial, that have occurred within historic times. Of course, the much desired permanency of channel and levee line would be impossible of attainment with cut-offs occurring from time to time, as the regimen of the river for many miles above and below each cut-off would be so disturbed as to render the works of improvement that might have been undertaken valueless.

The only means by which natural cut-offs can be obviated is by preventing the caving of the banks in the two bends on either side of the neck of land separating them. Here again the importance of the protection of caving banks is illustrated.

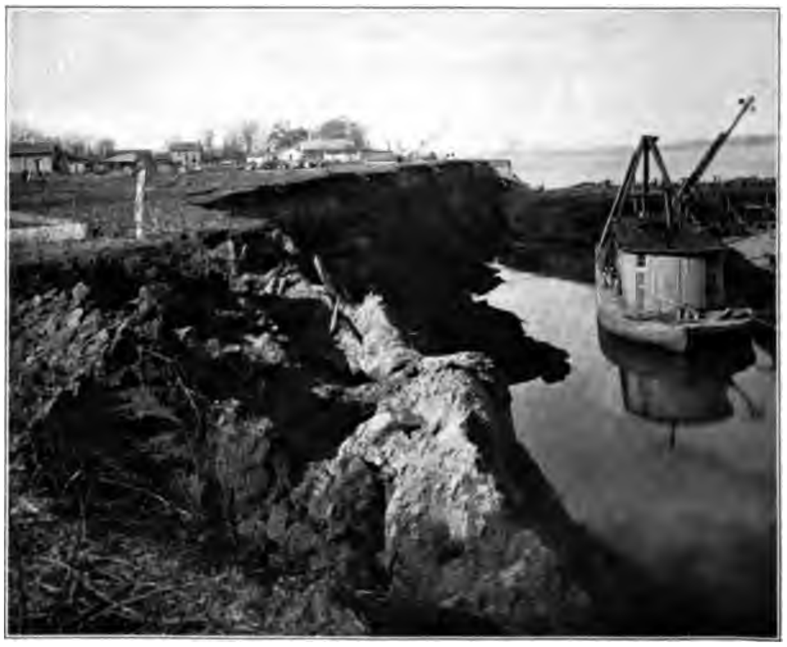
Modern civil engineering is largely the science of accomplishing the greatest possible results in the most economical manner. The belief that the Mississippi river is unique in that it cannot be controlled as other navigable streams are, is rapidly passing away. It is only a matter of time, ingenuity and money, and it is this latter factor that makes this or any other work practicable or impracticable. It would be possible to protect a caving bank by using thousands and thousands of tons of stone to rip-rap it, but the cost of such a method renders it impracticable. The present methods are the cheapest that have so far been discovered, and when it is considered that a cheap and effective form of bank protection practically solves all the vexing questions attendant on the improvement of navigation and the prevention of overflow, its paramount importance becomes evident.



CAVING IN OF LEVEE AT KEMP'S BEND.



CAVING BANK AT CARUTHERSVILLE, MO.



CAVING BANK AT CARUTHERSVILLE, MO.

THE LATE H. N. PHARR.

PAPER BY THE LATE H. N. PHARR

* * * You remember the dams you and your playmates built of gravel, sand and mud across the branch and watched it filling the basin thus formed, until it finally burst the dam and rushed down its channel, carrying gravel and sand with it. Following it down the stream you observed that its volume soon began to change form. The tendency was to elongate and subside. This continued until in the distance your flood disappeared. As it subsided you noticed that it began to drop its load, first its heavier part along the bottom of the channel and the sand along its convex banks, especially below the apex of the curve. Thus are shoals built in the channel and sand-bars extended down stream.

Then you had a flood wave governed by all the laws that control such waves in the Mississippi River.

There is a certain force of gravitation (weight) inherent in each atom of water. This accumulates as the volume increases, and while the volume is restrained it remains apparently latent, but is never latent. It was this force that burst your dam and started the flood down stream.

As soon as water begins to flow it acquires a second force, due to its velocity, and the resultant of these two forces, its momentum, is the working force of the stream at whatever stage it may be.

When we remember that water flows, *i. e.,* it moves by an interchange of atoms, which is so easy as to be excited by the least provocation, that this flow is governed wholly by its depth or aggregated weight and the inclination of the channel, which fixes its velocity, modified by the friction it encounters, each atom moving for itself under these laws, and is not in any sense projected or driven forward by an exterior force, that all waves subside by their own weight (gravitation), we are able to understand why your flood wave in the branch subsided. It did subside by increasing its length, because its banks restrained its width. The crest of the wave produced this elongation by restraining its rear and accelerating its front. Thus a stream flows faster as it rises than as it falls. Hence, all conditions being the same, a flood wave of any height will pass no two points at the same elevation. The difference will be in proportion to the distance, or the same thing, the time.

If we now leave the spring branch and go down to the creek we will find it, as you well remember, composed of a series of pools and shoals. A moment's observation will suggest the fact that no more water flows through the pools, whatever their capacity, than passes over the shoals. A difference in velocity is at once observed. This difference shows that there is a difference in their planes or a difference of "slope." The shoals more inclined, the pools less so. That is, the low water service is a series of planes, making angles more or less with each other.

If we follow the creek down to the old mill dam we find on our way that when we come to the head of the "mill pond" the creek just above is flowing on as if there was no dam across the creek and no pond there. If, on reaching the dam, we estimate the pond to be one mile long and find the dam to be eight feet high, observing the surface of the pond to be practically level, we infer that the slope of the channel is about eight feet to the mile. That is, the dam does not in any way affect the flow of the creek above the point at which a horizontal line laid on the surface of the pond, reaches the bottom of the creek, above.

We have seen such floods come down the creek as to cause the shoals to disappear—even the pool below the dam was filled and the water ran smooth over the dam. The dam is but a greater shoal in the creek. From this we learn that while the low water lies in a series of planes, more or less inclined, the effort of the water as it rises is to assume a uniform plane, and its nearest approximation of such plane is its high-water line.

Now, it is plain that no water runs through the pool below the dam that does not run over it, though it is wider and many times deeper than a cross-section on the dam would show. And it is just as plain that all the water that runs over the dam runs through the pool, and that it takes a certain depth of water on the dam to fill up the pool and maintain the uniform plane of the high-water line, and that no increased depth on the dam can raise the pool above that plane.

In the creek we have the river, differing only in such exaggerated features as art has contrived. If we now turn to the Mississippi River, we find the gauge reading of high water as follows: Cairo 52 feet, New Madrid 47 feet, Cottonwood Point 37 feet, Elmot 33 feet, Memphis 35 feet and Helena 48 feet. This shows us very plainly that there is a long shoal between Cairo and Helena, built up, doubtless, by long ages of annual overflow. To understand this it is only necessary to remember that the working force of water is proportional to its depth multiplied into its velocity. Anything that varies either or both of these factors varies that force. Now, that force is persistently occupied in an effort to remove matter from a higher to a lower plane, and always works to its full capacity, as it finds the banks and bars of the river an easy prey it goes loaded.

The overflow reduces both the depth and velocity—the depth by so much as is due to the volume of outflow, the velocity by so much as it due to the reduced depth added to the influence of the cross or counter current of the overflow. Thus is the force reduced, which at once drops so much of its load as is due to that reduction, and shoals are built along and below outflows.

This shoal between Cairo and Helena is distinctly shown by a profile of the zero of the gauges, and if the profile be extended it will show the river to be composed of a series of pools and shoals to New Orleans just as we have seen in the creek.

By examining the record of the reading of the gauges from Cairo to Helena for a number of years we find that the water rises faster at Cairo and Helena than at any point between. That is, as a rise comes on the pools fill up. Under the same conditions the relations between these gauges continues up to 40 feet at Cairo, which gives about 30 feet at Memphis and 40 feet at Helena. Up to this line the river is practically, if not strictly, within its banks, and the gauges show that 12 feet at Cairo gives 9 feet at Memphis and 12 feet at Helena. Above that line the outflow disturbs this relation. The next 12 feet at Cairo gives but 5½ feet at Memphis and 5 feet at Helena.

We see that 3½ feet of this 9 feet due at Memphis to this last 12 feet at Cairo has gone over the bank. If restrained between banks 52 feet at Cairo would give 39 feet at Memphis, less whatever may be due to increased velocity due to 3½ feet increased depth. This is all the extremists can claim.

But why does the 5½ feet at Memphis which has remained in the channel make but 5 feet at Helena, and not 7½ feet as heretofore? Plainly, because the Helena pool has filled at 40 feet on that gauge and is delivering over the next shoal below the water as it comes. That is, the conditions of a uniform plane have been established at 40 feet on that gauge. Thereafter a one-foot rise at Memphis makes one foot at Helena; hence when the restrained flood of 52 feet at Cairo makes 39 feet at Memphis it will make 49 feet at Helena, and can make no more. Hence, having the St. Francis Basin closed, cannot raise the high-water line a foot at Helena, but will doubtless restrain it slightly, which reduction will continue as the shoals are scoured out by the restrained flood.

Nine-tenths of all the water that heretofore has flooded the St. Francis Basin left the river between Point Pleasant and Bear Bayou, a distance of 66½ miles. That has been leveed, and the next flood will doubtless show a higher water line, due to the restrained outflow. This increased height of water line has been called an "abnormal" rise, due to the restraint—a secondary wave on top of the primary wave—and for evident reason it must subside more rapidly than the primary wave. Hence I say 52 feet at Cairo can never make 39 feet at Memphis nor 49 feet at Helena.

With this conclusion it is unnecessary to discuss the results from closing the St. Francis Basin upon the river below (they are prepared for 48.8 feet at Helena), further than to say that it will be very much to their advantage in this, that it will reduce the high-water period by from ten to forty days. It is not, as a rule, the height of the water that breaks levees, but the long-continued pressure. That is, it does not run over levees, but works its way through.

If you ask why, if this be true, the contention that now exists from Helena to the gulf against closing the St. Francis front, and why do the engineers sustain that contention? I confess it is not easy, from my standpoint, to answer that with the deliberation its importance demands.

For a great many years these people have been building levees. They have closed one basin after another. In each case there were not wanting prophets, who predicted the most calamitous results to follow, and those whose interests were to be affected became their ready followers. As one prediction failed it was transferred to the next case and their following increased by those to be affected until the whole became seized by a nervous apprehension of an imaginary calamity, and this, notwithstanding the fact well known to them that closing the Yazoo front for more than sixty (60) miles above did not raise the high-water line one foot at Helena, nor did closing the *whole* front of the great Yazoo Basin raise the high-water line one foot at Vicksburg.

Their predictions having failed up to this time, they now turn their attention to the St. Francis front with renewed energy. They determined that that front should not be leveed until they were certain of their own safety, while they have no idea what will give that safety. If their levees were built ten (10) feet higher and some new prophet, or some old one not yet exhausted, should raise the cry of impending ruin "the fat would be in the fire again."

Is it surprising that the engineers, who a few years before held a convention in Memphis to urge upon the citizens of the St. Francis Basin to organize and build that levee, not only for their own protection, but also for the protection of the whole levee system below by reducing their high water period, should discard all former experience, abandon their lines of reasoning and surrender their judgment to that nervous apprehension of calamity which pervades all classes, of which Col. Suter, corps of engineers U. S. A., member of the Mississippi River Commission and president of the Missouri River Commission, than whom no one is more competent to speak on any subject relating to the Mississippi River, says (see report of Mississippi River Commission to first session 54th Congress, Appendix I): "* * * The great progress made of late years in levee construction, coupled with the probability that in a few years the system will be substantially completed, has naturally aroused much interest throughout the whole valley of the Lower Mississippi. The increased flood heights due to this artificial restraint, although fully expected and predicted beforehand, have nevertheless created much anxiety among those persons who are personally interested in the matter and have aroused much apprehension as to what the final outcome will be. This feeling is by no means confined to ignorant persons, professional alarmists and cranks, but affects also so many persons of intelligence and influential position that some expression of this feeling in the shape of adverse legislation is much to be apprehended. This being the case, it seems to me to be the imperative duty of the commission to prepare for such a contingency beforehand and to avert, if possible, such action by such a statement of facts as will serve in some measure to relieve the public mind. In a general way it has been shown that the large increase of flood height has been mainly confined to intermediate points along the great swamp basins. At the lower end of these basins it has been slight, as for instance at Vicksburg. The only feature of uncertainty which now remains is to the effect of leveeing the St. Francis Basin. That this will increase flood heights at Memphis and all points above there seems certain, but so far as concerns the river below Helena there is this much to be said: All of the water which reaches the main stream above the junction of White River now passes Helena between levees, and hence has probably produced its maximum effect. There seems little reason for thinking that the height reached in 1886 will be much exceeded by any such floods as heretofore experienced." * * * *

I wish to add that since our levees have assumed such proportions as to be very costly their permanency becomes a question of much concern.

As long as the flood which drops more or less of its load along convex shores and is able to reload from the concave banks easier than from the bottom, the caving of the banks must continue and the deepening of the channel by scour must be retarded. Some method of controlling the current so as to protect the banks has long been an evident necessity to the levee system. The revetment idea at first inspired some hope, but it was soon seen that its cost and want of permanency would confine it to a few points where immediate relief was needed, and there to such an extent only as would permit of frequent rebuilding. As a project to control the river to such an extent as to protect the levees it was impracticable and doubtless never intended by the commission. It partook too much of that strategy which attacks an enemy in his own strongholds. It was therefore with much satisfaction that we saw the dredging and portable dyke idea introduced, which, if wisely applied, will not only affect the deepening of the channel, so much desired, but in that very act throw the current against the convex shores, cut off the bar and build up the concave bank. The whole thing is to get the current into the "middle of the road" and keep it there.

HON. KNUTE NELSON.

FLOODS OF THE MISSISSIPPI RIVER

REPORT OF THE MISSISSIPPI RIVER FLOODS, BY THE COMMITTEE ON COMMERCE, UNITED STATES SENATE, PURSUANT TO SENATE RESOLUTION NO. 76, FIFTY-FIFTH CONGRESS, FIRST SESSION

Mr. Nelson, from the Committee on Commerce, submitted the following report:

The Committee on Commerce makes the following report of the action of the committee, taken pursuant to the following resolution:

"Resolved, That the Committee on Commerce is hereby instructed to make full examination and inquiry as to the following questions and report thereon to the Senate, by bill or otherwise, on the first day of the regular session in December next:

"First. What are the causes of the disastrous floods in the Mississippi River and its tributaries, and how can such floods be prevented or diminished?

"Second. If such floods are the result to any extent of the destruction of timber upon or near the head waters of said river or its tributaries, what measures should be adopted to prevent such destruction, and whether reservoirs to hold the water caused by rain or the rapid melting of snow on or near said head waters should be constructed to prevent the floods caused by the sudden precipitation of the rain or snow water into the streams flowing from the regions where the sources of the Mississippi and its tributaries are located.

"Third. Whether said reservoirs, if their construction should be deemed necessary for the purposes before set forth, could not also be utilized for the irrigation of arid lands in the vicinity of such reservoirs.

"Fourth. Whether the outlet system by which it is proposed to furnish avenues through which the waters of the Mississippi River can escape in times of flood is practicable or expedient.

"Fifth. Whether the present system of improving the Mississippi and Missouri rivers under which it is sought to confine the water within the banks of said rivers, by means of levees, and by such levees, together with jetties at different localities, to increase the erosive power of the current so as to protect the banks and deepen the channel, should be continued.

"Sixth. What has been the effect upon navigation and commerce of the jetties at the mouth of the Mississippi River, and what is the present condition of said jetties and their probable future?

"Seventh. Whether the Mississippi and Missouri River Commissions should be continued in existence, and, if continued, what amendments should be made to the statutes creating such commissions and defining their duties and powers.

"Eighth. What legislation is necessary to prevent the enormous destruction of property by floods in the Mississippi River and its tributaries, and what amount of money should be appropriated by Congress for the establishment and maintenance of systematic improvements and safeguards for said purposes?

"That said committee shall have power to prosecute its inquiries through a sub-committee, which may sit during the recess of the Senate at such times and places as may be thought necessary, with power to send for persons and papers, and to employ a stenographer, the expenses of said committee to be paid from the contingent fund of the Senate."

The investigation contemplated by the resolution was carried on through a sub-committee composed of Senators Nelson, Elkins, Vest, McBride, Gallinger, Berry, and Caffery.

In October, 1897, the sub-committee visited the reservoirs at the head waters of the Mississippi, also St. Paul, Rock Island, and St. Louis on the Mississippi River, and Sioux City on the Missouri River, and took the testimony hereto appended. In February, 1898, the sub-committee went to Cairo, Ill., and from there on the Mississippi River down to the Gulf of Mexico on the boat of the Mississippi River Commission, and on this trip took the residue of the testimony hereto appended. The testimony so taken is comprehensive and instructive, covering every feature of the contemplated inquiry. In addition to the facts and data derived from the testimony, your committee have also derived much valuable information from a pamphlet on The Floods of the Mississippi River, by William Starling, chief engineer of the Lower Yazoo levee district, 1897, and from Bulletin E of the Agricultural Department on the Floods of the Mississippi River, prepared by Park Morrill, under the direction of Willis L. Moore, Chief of the Weather Bureau, 1897. The pamphlet will be cited as "Starling," and the bulletin as "E."

The questions propounded for the investigation of the committee are to a large extent questions of science and engineering, and the committee can do little more than to briefly summarize the opinions and conclusions of experts.

CAUSES OF THE FLOODS.

The principal territory submerged or affected by the floods of the Mississippi River before the construction of levees, and in part since, consists of certain basins or bottoms along the banks of the river between Cairo and Forts Jackson and St. Phillip. These basins, from Cairo down, are as follows:

The St. Francis Basin, on the right bank of the river, extending from Cairo to Helena, near the mouth of the St. Francis River, and embracing an area of about 6,706 square miles.

The White River Basin, on the same side of the river, extending from Helena to near the mouth of White River, and embracing about 956 square miles.

The Yazoo Basin, on the left bank of the river, extending from a short distance below Memphis to a point near the mouth of the Yazoo River, and embracing, in all, about 6,648 square miles.

The Tensas Basin, on the right bank of the river, extending from near the mouth of the Arkansas River to near the mouth of the Red River, and embracing an area of 5,370 square miles.

The Atchafalaya Basin, on the same side of the river, extending from the junction of the Red and Atchafalaya rivers to Fort Jackson, and embracing 8,109 square miles, and

The Pontchartrain Basin, on the left bank of the river, extending from Baton Rouge to Fort St. Phillip, and embracing an area of 2,001 square miles.

The aggregate area of all these basins is 29,790 square miles, or 19,065,600 acres. (Test., 431.) Ever since the immediate valley of the river below Cairo has been settled there has been a constant struggle to reclaim these basins and to protect them against overflows and floods. The problem has been in part accomplished, chiefly by means of levees, but much still remains to be done. The ultimate object of this investigation was to determine the best method for the complete and permanent protection of these basins against the floods and inroads of the river.

The Mississippi river at Cairo is composed of the waters of the Ohio, the Upper Mississippi, and Missouri rivers. The Ohio and its chief tributaries have their sources in the western slopes of the Allegheny Mountains and their spurs. The Upper Mississippi and its principal tributaries have their sources in numerous lakes in that plateau of land between the Red River of the North and Lakes Michigan and Superior, and the Missouri has its source in the upper eastern slopes and foothills of the Rocky Mountains. The White and the St. Francis rivers, with sources in the Ozark Mountains, in southern Missouri and northwestern Arkansas, and the Arkansas and the Red rivers, with their sources in the lower eastern slopes of the Rocky Mountains, contribute considerable volumes of water to the Mississippi river within the basins subject to overflow.

The annual normal rainfall in the different river basins varies greatly. In the Ohio it is 44.2 inches; in the Upper Mississippi, 31.9; in the Missouri, 19.4; in the Arkansas, 29.6; in the Red, 39.1, and in the central valley of the Mississippi, including the White and the St. Francis, 51.4 inches (E, 24 and 25). In the Upper Mississippi and the Missouri the rainfall is, as a rule, greatest in May and June. In the Ohio and the central valley it is greatest in January, February and March (Starling, 22 and 23).

The greatest and most destructive floods have generally come from the Ohio. This was the case with the great floods of 1882, 1883, 1884, and 1897; and these floods culminated in February or March (E, 40-45, and Starling, 29 and 41). Of the total amount of water passing Cairo during these floods the Ohio contributed 69 per cent in 1882, 70 per cent in 1883, 85 per cent in 1884, and 76 per cent in 1897 (Starling, 27 and 41). These great floods from the Ohio river, like all similar floods, came from excessive rains in the basin of the Ohio and its tributaries. These rains arise from cyclonic storms and warm, moisture-laden winds, originating in the Gulf of Mexico, and passing thence up the central valley and the valley of the Ohio into the western slopes and spurs of the Allegheny Mountains, where a colder atmosphere is encountered, leading to the precipitation (Test., 267).

The Ohio floods, after passing Cairo, are frequently largely reinforced by floods from the White and St. Francis rivers and other streams in the central valley. Occasionally the floods from the Missouri and Upper Mississippi are, to a limited extent, a factor in extending or prolonging the flood on the lower river, but this applies rather to the May and June freshets of the Ohio than to the earlier and more extensive ones (Starling, 24 and 25).

In Bulletin E (p. 46) the "Cause of the Mississippi floods" is thus summarized:

"It is, of course, conceivable that a flood should occur in the Lower Mississippi from heavy precipitation over any of the great contributary basins. In these floods of the past quarter century we do not, however, find the western tributaries playing an important part. The great source of floods is the Ohio Basin, with its steep slopes from the crest of the Alleghanies, upon which falls the heaviest rains of spring at a time when the normal rise of the Lower Mississippi brings the river almost to the danger line from Cairo to the Gulf. In the greatest floods we also find that heavy rainfall over the great swamp region that extends along the Mississippi from the mouth of the Ohio to the Gulf of Mexico is an important factor. Third in importance as a factor in producing floods is the Upper Mississippi, which, while never discharging a volume sufficient to produce of itself a flood, yet, rising later than the Ohio, serves to prolong the high water, and thus to increase the overflow."

There are other causes, to which we shall refer further on, which have tended more or less to aggravate the destructive features of recent floods, but the foregoing presents briefly, and in a general way, the primary and chief cause.

DESTRUCTION OF FORESTS.

Nothing in the evidence or other data obtained by your committee discloses the fact that the destruction of timber at or near the head waters of these river systems tends to cause or promote the floods referred to. It was shown that where timber is cut down for purposes other than cultivation the underbrush remains and grows more luxuriant than ever, and such underbrush serves to retard rather than hasten the movement of water on the slopes and hillsides; and where timber is cut down for purposes of clearing and cultivation the plowed area becomes an enlarged absorbent of surface moisture: It is a generally accepted opinion that the destruction of timber tends rather to diminish than to increase the rainfall.

RESERVOIRS.

There are five reservoirs constructed at the head waters of the Upper Mississippi. These reservoirs repress to some extent the floods in the river bottoms above Lake Pepin and improve the navigation of the river in low water down to that point, but have no material effect upon the floods or navigation of the river below that point. The evidence discloses no other points on the Upper Mississippi available for reservoir purposes. On the Missouri the only point where sufficient holding ground could be found for a reservoir of any magnitude is on a reach of the river above Great Falls. Such a reservoir, if constructed high enough to bring the waters of the Missouri river into the Milk River Valley, would be valuable for purposes of irrigation, but would have no material bearing on the floods in the Mississippi river, nor on the navigation of the Missouri river.

The evidence, as well as the other data, discloses that on the Ohio River, as well as its main tributaries, where reservoirs could act more directly on the floods than elsewhere, with the exception hereinafter stated, there are no suitable sites or holding grounds where reservoirs could at any moderate or reasonable expense, and without working far-reaching and extensive damage, be constructed that would at all be adequate to pen up and retain the great downpour from innumerable mountain torrents during the great freshets of January, February and March. There are no great basins adequate for reservoir purposes either on the Monongahela, the Allegheny, the Tennessee, or the Cumberland; and to be effective in repressing the floods of the Ohio, big, strong reservoirs would be requisite on these streams.

The only place where a reservoir basin can be found, proximate and sufficiently large to afford a holding ground at all commensurate with any material or practicable relief, is the St. Francis Basin; but the cost of constructing and maintaining a system of reservoirs in this basin would be enormous, and far greater than the cost of leveeing the entire river front of the basin. The scheme is regarded by nearly all engineers and other experts as wholly impracticable. In short, your committee can discover no just or adequate relief in reservoirs.

OUTLETS.

Neither can your committee discover from the evidence, or through other sources, any material relief from the outlet system. It is not practicable to relieve the river by means of outlets except below the Red River. Two important natural outlets now exist and have for years existed on this reach of the river—the Atchafalaya and Bayou Lafourche. A third, Bayou Plaquemine, is now closed pending its preparation for reopening by means of locks and dams. But these outlets, or others that might be constructed on this reach of the river, could afford no perceptible relief for the river above, where relief is much more called for and needed. The St. Francis, Yazoo, White and Tensas basins can get no relief from any practicable outlet system. And where this system exists and is feasible there is no disposition to extend it or to subtitute it for levee enlargement. (Test., 424-455, 335, 375; see also Humphrey and Abbott's report of 1861 as to reservoirs and outlets.)

LEVEES.

The history of levee construction on the Mississippi River has been a history of the gradual reclamation of the several basins or bottoms from the inroads of the floods of the river. Anterior to levee construction these basins served as great natural reservoirs for the floods, the exterior hills or ridges of the basins serving as the high-water banks of the river; and within these banks so wide apart and with these basins for a high-water bed, the floods never reached the high level nor the increased rapidity obtained since the great extension of the levee system. Levees are the penning up of the floods of the river from these high-water basins. The narrowing of the high-water stream by means of levees does not result in materially scouring a deeper channel nor in raising the bed of the river (Test., 269), and so the stream at its flood stages, as it becomes narrower, also becomes higher. Contraction without deepening of necessity leads to elevation, and as a consequence levee construction has brought in its wake higher flood levels, necessitating from time to time higher and stronger levees. The history of levee construction shows this. (Dabney, Test., 311; Driver, Test., 199; Starling, Test., 269; Gillespie, Test., 382, 383; Newcomer, Test., 334; Richardson, Test., 370, 371; Taylor, Test., 237, 239, 241; Table, Test., 432; Tollinger, 510.)

The first levee construction began in 1717, when a levee 1 mile long was constructed to protect New Orleans, then a mere village. This levee was 4 feet in height and 18 feet across at the top. The country settled up slowly, and levee construction only kept pace with the settlement. Fifty years after this levee was built the settlements extended only 30 miles above and 20 miles below the embryo city. It was not until after Louisiana had been ceded to the United States that levee extension was undertaken on an enlarged and systematic scale. By 1828 the levees, though of rather inferior character, had been extended nearly up to the mouth of the Red River. At the beginning, a levee 4 feet in height was ample, but as levee construction progressed up the river, and additional basins and bottoms were inclosed and protected, the levees were, of necessity, increased in height (Test., 237). There are still levees below New Orleans that are only from 3 to 4⅓ feet in height, but the average height of the levees in Louisiana, above New Orleans, is now from about 12 to 13 feet (Test., 380, 369), and this height proved insufficient in the great flood of 1897 (Test., 370).

The flood stage of 1897, above New Orleans, was from 1 1-3 to 3½ feet higher than that of any previous flood, notwithstanding that the flood level at Cairo was less than in 1882-83 and 1884. Three great crevasses occurred in 1897 that remained unrepaired until after the flood subsided, and several minor crevasses occurred, which were closed during the pendency of the flood. This increased flood level was "partly due to the improvement and increase of levees." (Test., 370, 371, 380, 423, 424.) The experience of 1897 indicates that a complete inclosure of all the river basins will require from 3 to 4 feet higher levees in Louisiana. The levees on the Yazoo Basin were only 4 feet high in 1858. From 1874 to 1882 they were raised to from 7 to 8 feet (Test., 269-308), which proved insufficient under the flood of 1882; and based on this flood as a standard, the levees were increased to an average of from 13 to 14 feet in height prior to 1897. This was more than 3 feet above the high water of 1882 (Test., 308-311), but it proved utterly insufficient under the flood of 1897.

Since the floods of 1882-83 and 1884 the White River Basin, the Upper Tensas Basin, and much of the St. Francis Basin have been inclosed, and this, together with the higher levees on the Yazoo front, have greatly aggravated and raised the flood levels on this reach of the river (Test., 269, 272, 273, 311). The flood of 1897 made it plain that a complete inclosure of all the river basins would require an increase of from 4 to 6 feet in height of the Yazoo levees. (Test., 274-275, 311; see Starling's paper on levee construction in Yazoo Basin, Test., 505-508.)

The work of inclosing the White River Basin was commenced in 1888, and most of it was done after 1890. By 1897 the basin had been inclosed by a levee of an average height of twelve feet, deemed sufficient under the flood levels of 1882-83 and 1884, but this proved utterly insufficient in the flood of 1897. That flood overtopped the levee at many points, and was from 4 to 6 feet higher than any previous flood, clearly indicating that a complete levee system along the entire river would require an increase of six feet in the levee height along this basin. (Test., 301, 302.)

In the Upper Tensas Basin nearly all levee construction has taken place since 1882—mainly since 1892. In the Lower Tensas Basin there was an old levee existing before this period, but of low grade and insufficient in strength. By 1897 the Upper and Lower Tensas Basin levees had attained an average height of thirteen feet. In the flood of 1897 the river was from two and one-half to three feet higher in front of these basins than in the flood of 1882, and hence the levees were insufficient. Had the water in 1897 not been any higher than in the floods of 1882-83 and 1884, the levees would have been ample. (Test., 330-332.) Several serious crevasses occurred in these levees during this flood. The higher flood level of 1897 was largely due to increased levee construction and the further inclosures of river basins. (Test., 334.) The completion of the levee system would require the levees on the Tensas Basin to be raised to the height of from seventeen and one-half to eighteen feet. (Test., 334, 335.)

In the St. Francis Basin levee construction began in 1893. Since that time a continuous levee of an average height of nine feet has been constructed from Point Pleasant, Mo., to Chute 38, Arkansas, a distance of 127 miles. About 100 miles more are required to reach the mouth of the St. Francis river and to entirely inclose the basin. The levees on the St. Francis Basin proved insufficient for the flood of 1897, and several serious and extensive crevasses occurred. These levees need to be made stronger and higher—at least two feet higher than the grade of 1897. (Test., 167-170.)

The flood of 1897 wrought great havoc, especially in the older levees, many of which had been defectively and improperly constructed. There were twenty-three breaks in the St. Francis front, six in the Yazoo front, fourteen in the White river front, and four in the Tensas front, most of which occurred from an overtopping of the levees. Below the Red river there were only a few small breaks, and these were closed during the pendency of the flood. (Test., 432.) Engineer Ockerson, in his testimony (p. 432), describes the flood of 1897 and compares it with the flood of 1882 as follows:

"From a point about 100 miles below Cairo to the Gulf the stage reached in 1897 was greater than any previous record. As far as volume of water is concerned, however the flood of 1882 was much greater than that of 1897. The flood of 1882 stood above the danger line at Cairo, or forty-two feet on the gauge, for a period of seventy-two days. The flood of 1897 stood above the danger line for a period of fifty-four days. During the flood of 1897 the tributaries below Cairo were all rather low."

Table showing relative heights of floods of 1882 and 1897.

	1882.	1897.
Cairo	51.9	51.6—0.3
Belmont	45.1	45.1 0.0
New Madrid	40.9	40.3—0.6
Cottonwood Point	37.5	39.3+1.8
Fulton	36.7	47.5+0.8
Memphis	35.2	37.7+2.5
Mhoons	39.8	41.6+2.8
Helena	47.2	51.8+4.6
Sunflower	41.7	47.3+5.6
White River	48.4	52.4+4.0
Arkansas City	47.1	51.9+4.8
Greenville	41.7	46.8+5.1
Lake Providence	38.3	44.4+6.1
Vicksburg	48.8	52.4+3.6
St. Joseph	44.9	47.9+3.0
Natchez	47.8	49.8+2.0
Red River	48.5	50.2+1.7
Bayou Sara	39.3	43.8+4.5
Baton Rouge	36.0	40.7+4.7
Plaquemine	31.3	36.3+5.0
College Point	23.2	28.0+4.8
Carrollton	15.0	19.0+4.0

A due consideration of the testimony and other data bearing on the subject makes it clear that the flood of 1897 was, in its effects and consequences, greatly enlarged and aggravated by the extensive inclosure of basins and the extended and enlarged levee construction that had taken place since the floods of 1882-83 and 1884 (Test., 241), though it is doubtless true that if no levees at all had been in existence a larger area would have been submerged. Engineer Starling, in his book (41, 42), to which we have already referred, concurs in this conclusion in the following clear and apt language:

"It is not only the magnitude of the flood of 1897 which has made it of surpassing importance to the engineers of the Mississippi service. The widespread damage which it has wrought, while great, is yet not without a parallel. Its principal interest to the engineer is due to the experience which has been derived from the wholesale closure of unleveed tracts and the extraordinary elevation of its high-water line consequent thereon. There are two of the great basins into which the Mississippi Valley is divided which have only recently been protected to any extent by levees. These are the St. Francis and the White river basins. The former was closed during the last three years, or since the flood of 1893, to a distance, measured along the river, of about 120 miles. There still remains a gap of about 100 miles. The White River Basin has been undergoing a gradual process of closure for several years. In 1893 there was a gap of about fifteen miles, extending between points 330 and 360 miles, respectively, by river, below Cairo. In 1896 this gap was closed and the line of levee was made continuous from the hills at Helena to a point eight miles above the mouth of White river. It is to the building of these lines and to the maintenance of the lines previously existing until a late period of the flood that the unparalleled stages attained by the water have been due."

The construction and repair of levees was, in the first instance, undertaken by riparian owners, afterwards by parishes or counties, then by the States or certain levee districts, under the authority of the States, and finally by the latter and the Federal Government combined, which is the system now prevailing. The first material aid given by the Federal Government was a grant of swamp and overflowed lands; made to the several States in 1850. The same year Congress also made provision for a survey and investigation of the Mississippi river.

This work was carried on for the next ten years under the direction of Captain Humphrey and Lieutenant Abbott, who made their final report in 1861. This report was most thorough and exhaustive, and is still the standard work on the hydraulics and physical features of the river. It made clear that no substantial relief from the floods could be obtained from reservoirs or outlets, and that levees, properly constructed, would afford the necessary relief and protection. Neither the testimony taken by your committee, nor other obtainable data, has shaken or invalidated these conclusions. During the civil war levee construction was at a standstill. After the war was over the several States began, without concert and without due plan or system, to extend and repair the levees. But the great flood of 1874 showed how inadequate, both in quality and quantity, the efforts of the States were. Congress again intervened, and passed an act providing for the appointment of a commission of five engineers to investigate, determine, and report as to the best plan for relief against the floods.

This commission made its report in 1875, and came to the same conclusion as Humphrey and Abbott did in 1861, that a system of levees could alone afford adequate protection. But no systematic improvement of the river by the Federal Government was yet undertaken. Finally, in 1879, Congress passed an act creating the Mississippi River Commission, outlining its work in the following terms:

"It shall be the duty of said commission to take into consideration and mature such plan or plans and estimates as will correct, permanently locate, and deepen the channel and protect the banks of the Mississippi river; improve and give safety and ease to the navigation thereof; prevent destructive floods; promote and facilitate commerce, trade, and the postal service."

From 1879 to 1882 $1,475,000 was appropriated by Congress for expenditure by the commission in making surveys and in improving the navigation of the river, but none of it was allotted for levee construction. In 1882 Congress appropriated the gross sum of $4,123,000, and from this the first direct allotment for levee construction was made—about $1,300,000 in all. (Test., 237.)

The testimony of Judge Taylor, a member of the commission, explains in detail the make-up of the commission, the mode in which it performs its work, and the methods it pursues. From each appropriation made the commission allots a certain proportion for the construction and repair of levees in each levee district, which is expended by the United States engineer in charge of the district. The commission plans the work, subject to the approval of the War Department, and the district engineers carry on the work conformable to the plan.

The first effort of the commission was directed to the closure of the Yazoo Basin, and then followed the improvement of the Tensas Basin, then the White River Basin, and, finally, a part of the St. Francis Basin. In the respective levee districts the State and Federal engineers, while acting in concert and harmony as far as possible, work each on separate and distinct portions of the river. One reach is constructed under Federal authority and another under State authority. When a levee is constructed, the constructing engineer or his successor takes charge and care of the same. (Test., 257, 258.) In case of an emergency there is by mutual consent a sort of joint care and supervision. As a rule, both Federal and State engineers are men of fine attainments, high character, and great public spirit, which tend to obviate any friction that otherwise might ensue from an undefined joint tenancy. It would no doubt be advisable to provide by law in which authority the care and maintenance of a constructed levee should vest.

The evidence (p. 518) discloses the fact that eighteen suits have been brought against the United States for damages claimed to arise from the construction and maintenance of levees or failure to construct or maintain proper levees along the Mississippi river. The aggregate amount of damages claimed in these suits is $656,337.04.

From a table (following p. 518 of testimony) prepared by Captain Waterman, secretary of the Mississippi River Commission, under the direction of General Gillespie, president of the commission, it appears that the total yardage of levees constructed by Federal, State, local, and private authority is 164,860,375 yards, built at a cost of $47,631,503.78, of which yardage 68,570,431 yards were constructed by Federal authority, at a cost of $13,320,708.44, and 96,289,944 yards by State, local, and private authority, at a cost of $34,310,795.34.

It is estimated that it would cost to complete the entire levee system, from the head of the St. Francis Basin to the Head of the Passes, at a grade sufficiently high and strong to afford complete protection against floods at the highest probable stages, the sum of from $18,000,000 to $20,000,000, and that it would take from four to five years to complete the system. (Test., 245, 246, 390, 396, 408, 357, 360.)

From all the evidence taken and considered by your committee it is evident that the basins and bottoms along the Mississippi river exposed to the floods of the river can only be protected and preserved from such floods by an ample and complete system of levees from Cairo to the Head of the Passes.

Crevasses and inundations, resulting in extensive loss of life and property, are liable to occur during all floods so long as the system is incomplete. The burden of completing the levee system is too great for local and State authority. Your committee are of the opinion that the Federal Government should continue, as it has since 1882, to aid in the great task of controlling and repressing the floods in the river.

Your committee are also of the opinion that the Mississippi River Commission should remove its principal office and headquarters from New York City to some point on the Mississippi river.

NAVIGATION, MISSISSIPPI RIVER.

The testimony discloses that the navigation of the Upper Mississippi river has been considerably improved by the reservoirs, on the reach above Lake Pepin, and by riprapping, wing dams, spur dikes, hurdles, revetment works, and a little levee work at various points on the river below that reach. (Test., 20-34.)

The Mississippi River Commission has carried on more or less extensive improvements of the navigation of the river on many of the reaches below Cairo. Such improvements, in addition to levee work, have consisted of bank protection in the form of riprapping and various kinds of revetment work, of channel contraction by means of jetty work, hurdles, and various forms of spur dikes, and of dredging on an extensive scale. Some of the work has been rather tentative and of a temporary character, and on account of the great cost has not been followed up.

At present, aside from the levee work, the chief reliance for obtaining a low-water navigable channel seems to be dredging. The new style of hydraulic dredges seem to be very potent and effective, and seem to give great and promising results. Four new dredge boats have been for some time completed and in use, and two more are under contract and by this time ready for use, and there is money available for another dredge. It is estimated that from nine to ten dredges will be required to keep a due low-water channel open. (Test., 100-108, 140-148, 218-235.) In the light of results obtained, your committee recommend that ample provision be made for the construction of dredge boats, and dredging. In view of the great cost, especially great as to results, it seems that it would be more judicious to limit revetment work to levee and harbor protection. Contraction, by means of jetties, dikes, and dams, supplemented by dredging, seems to have given the best results at least cost. There is no doubt that revetments are very efficacious, but the cost is so immense that its systematic application is scarcely warranted.

JETTIES AND PASSES.

As the Mississippi river in its downward course is about to debouch into the sea it divides itself into three great passes, through which it enters the Gulf, and forms the delta at its mouth. These passes are known as the Southwest Pass, South Pass, and Pass a Loutre. From New Orleans down to the Head of the Passes there has been no impediment to deep-water navigation. The impediment occurs in the passes, especially at their heads and mouths, chiefly the latter. Prior to the improvement of the South Pass by means of jetties, navigation was chiefly confined to the Southwest Pass, though Pass a Loutre had for some years been utilized to some extent.

In 1839, when the Southwest Pass was first examined, it was 15.2 miles long and 13 feet deep on the crest of the bar, and it was then, as now, of an average width of twice the width of the South Pass. Between that time and 1877 considerable work was done in improving this pass, but such work, aside from a short and abortive jetty work on one side of the pass in 1856, consisted of dredging and stirring up the bed of the channel by means of drags, harrows, scrapers, blasting, torpedoes, and other similar appliances. By these means a depth of 18 feet was at one time, for a short period, obtained on the crest of the bar. In 1874, the year before the improvement of the South Pass began, the Southwest Pass had attained a length of 18 miles, with a depth of only 15 feet on the crest of the bar, and on the 9th day of February last the pass had attained a length of 18½ miles, with only a depth of 9 feet on the crest of the bar, according to soundings then taken. (Test., 464.)

In aid of the improvement of the South Pass Captain Eads placed a mattress sill across the head of the Southwest Pass, which, aside from a little dredging prior to 1878, is the only improvement made in this pass since 1875.

Prior to 1875 like efforts at improving Pass a Loutre, except jettying, were also made, which were, in like manner, partially successful. By the fall of 1858 an 18-foot channel had been obtained in this pass, and for some years it was, on account of being the shorter pass, utilized for purposes of navigation; but in 1875 the channel was destroyed by a large mud lump, and since that time no improvement has been made, except placing a mattress sill at the head of the pass and the work of attempting to close a large crevasse on the south side of it near the upper end, both of these works being in aid of the maintenance of the South Pass jetty system.

The South Pass in 1838 was 11.3 miles long, 700 feet wide, except at the extremities, and 8 feet deep on the crest of the bar. In 1875 it was about the same length and width, but only 7 feet deep on the crest of the bar. In 1874 a board of engineers, consisting of 3 army engineers, 3 civil engineers, and 1 from the Coast and Geodetic Survey, was appointed to devise and determine upon some plan of securing deep-water navigation through one or more of the passes. This board, after visiting Europe and examining many works there involving similar problems, recommended, in January, 1875, the improvement of the South Pass by means of jetties. In pursuance of this recommendation Congress, in March, 1875, conferred the task of making the improvement upon James B. Eads and associates. The jetties were practically built on lines recommended by the board.

The original act provided for a channel 30 feet deep and 350 feet wide, but by 1878 it became evident that such a channel could not be obtained by the work then laid out, and accordingly Congress was induced to remit, by acts passed in 1878 and 1879, the requirement to a channel 200 and 250 feet wide and 26 feet deep, and on this basis the work was deemed completed in July, 1879. In making the improvement, and as a part of it, training dikes were built at the Head of the Pass, and mattress sills were laid at the head of the Southwest Pass and Pass a Loutre. In 1891 the west end of the Pass a Loutre sill was carried away, and a large break occurred on the west bank of Pass a Loutre about 1½ miles below the head of the South Pass.

This break, although several attempts have been made to close it, has not yet been closed, and in consequence thereof, as well as on account of the loss of the contiguous end of the Pass a Loutre mattress sill and portions of the training dikes, and lack of repair and maintenance in some of the training dikes, the inflow of water into the South Pass has been less than before, which has, no doubt, to some extent detracted from the scouring force in the pass, necessitating some dredging, for the maintenance of the requisite channel. Before these drawbacks occurred the pass received from 10 to 11 per cent of the water in the main stream; since then only 7 per cent. Three hundred feet of the jetties at the sea end have been washed away on both sides, and in addition to this 150 feet of the jetty on the west side. None of the jetties thus washed away have been replaced. The east dike at the head of the pass has also been washed away. This was a training dike, 1,250 feet long, and has never been replaced.

There is also an open and exposed gap 1,100 feet long between the end of the Pass a Loutre mattress sill and the end of the bank or dike on the east side of the pass. This gap was, when the work was completed, filled with a training dike. Five hundred feet of the mattress sill in Southwest Pass has also been carried away. In short, neither the jetties nor the training dikes nor mattress sills have been kept up to the condition they were in 1879, but have been allowed to diminish and deteriorate.

Up to 1889 the channel was maintained at the required depth substantially without dredging. Since that time it has deteriorated and has not been maintained without considerable dredging. During the year ending June 30, 1896, there were one hundred and sixty-nine days of dredging. Within the last four years there has been an average of one hundred days dredging each year. The channel was not kept at the required depth for forty-seven days during the year 1897. On the whole, it appears that, although the jetties have accomplished much good and great results, they have not wholly succeeded, owing to the causes enumerated, in maintaining the fine channel that existed from 1879 to 1889. To maintain the good results then obtained the dikes, sills, and jetties carried away should be replaced or restored as far as practicable. Besides, the jetties should be extended seaward farther than originally built in order to keep pace with extension of the bar into the Gulf.

Jetties are the artificial extensions of the natural banks of the stream, and as the bed of the stream is, from the sill moving in the river, prolonged into the Gulf, the jetties must, of necessity, keep pace with such extension. For practical purposes the pass is not adequate for vessels drawing over 24, or at most 25, feet of water. This is insufficient for the wants of modern commerce. Vessels drawing from 27 to 30 feet and over are now quite common and much more economical than small vessels. It is very doubtful whether a channel sufficient for this larger class of vessels can be obtained in the South Pass. Major Quinn maintains that it can. Engineer Donovan, with a twenty-year acquaintance with the pass, maintains that it can not.

Your committee visited the pass in February last, and, with a 26-foot channel, found the pass bank full at all points. Unless the pass can absorb much more water the scouring process can not be increased nor a deeper channel obtained by that method. To secure a greater volume of water it would be necessary to build and prolong great training dikes at the head of the pass and to fortify them with mattress sills and other works, so as to bring about a larger inflow. In the next place, it would be necessary to build strong and extensive levees on both sides of the pass from the head to the jetties. There is scarcely sufficient foundation for such levees. The earth and riprapping would have to be brought from a great distance, and the embankment would be subject, more or less, to the storms, the waves, and the back wash of the Gulf. In short, such leveeing would be an extensive and most expensive jettying from the head of the pass to deep water in the Gulf. These are some of the difficulties which occur even to the lay mind. To say the least, the cost would be enormous and the result very problematical.

But the commerce of the Mississippi Valley asks and is entitled to a much deeper and broader channel to the sea than that now afforded or likely to be afforded by the South Pass. The Southwest Pass is regarded in many quarters—lay and expert—as the cheapest and most feasible route through which to obtain the requisite deep-water navigation. Congress has already made provision for a thorough examination and survey of this route. The engineers having the work in charge have not yet made their report, and until they do it would be premature for us to suggest or advise. We may add that to improve the Southwest Pass and at the same time to maintain and utilize the South Pass, thus securing the advantages of two passes, is no novelty.

This plan was adopted in 1856, when provision was made and work carried on for the improvement of both the Southwest Pass and Pass a Loutre. In case of extensive repairs or accidents there would always be one pass open and available for navigation. (See Major Quinn, Test., 443-463; Engineer Donovan, Test., 466-482; Engineer Ockerson, Test., 463-465; also his article on "The problem of deep-water navigation through the passes," etc.; also Test., 440-443, 483-490, 493-503.)

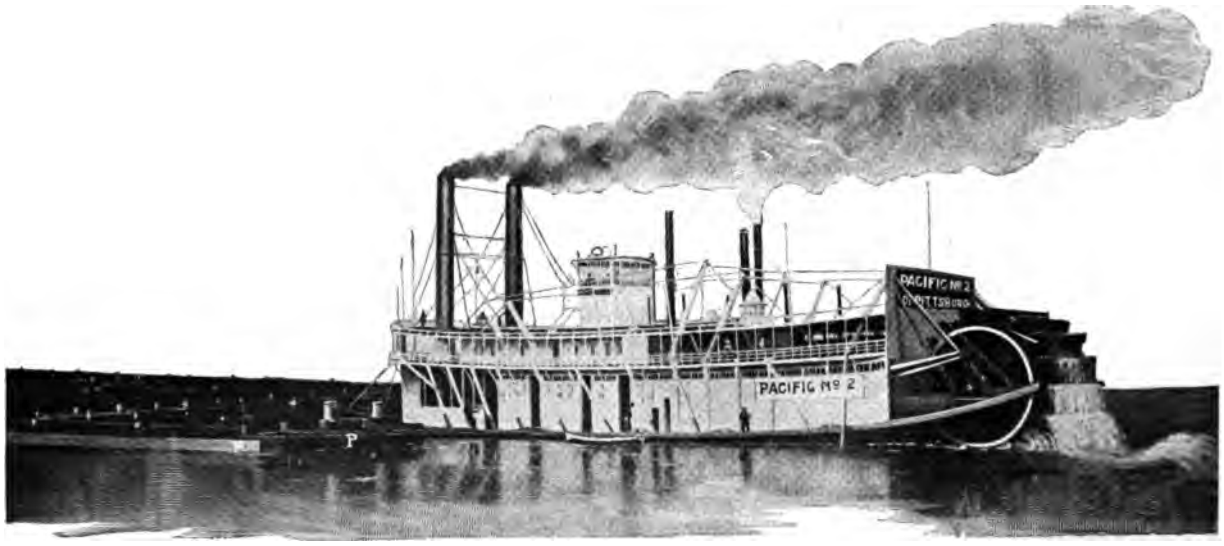
MISSOURI RIVER AND MISSOURI RIVER COMMISSION.

In respect to the Missouri River Commission and its work we beg leave to state that it has had charge of the river from Sioux City to its mouth, and that its work in recent years has been chiefly confined to the improvement of the navigability of some 45 or 46 miles of the lower reach of the river and to so-called harbor improvements for the protection of the river fronts of towns from the inroads of the river on the other reaches of the river. The work done has no doubt been beneficial for the purposes intended, and the money appropriated has, under the limitations stated, been judiciously expended.

The Missouri River is so eccentric and uncertain that great difficulties are encountered in controlling its movements from year to year, and nothing but systematic and patient effort can avail in its improvement. The commission has recommended in all its reports the improvement of the river by reaches, commencing at the mouth; and the work done under this system has proved eminently successful, but Congress has unfortunately permitted the appropriations for the general improvement of the river to be diverted to local improvements, which, being isolated and unsupported, are usually swept away by the annual overflows.

The condition of the river, by reason of the failure to adopt systematic and continuous improvement by reaches, as recommended by the commission, has been so bad as to discourage navigation, the rates of insurance upon boats and cargoes being absolutely prohibitory.

Your committee is of opinion that in view of the great agricultural wealth of the country through which the Missouri River flows, and especially the enormous production of grain, the river should be so improved as to afford every facility for its navigation by boats and barges, so as to prevent excessive charges by railroads, and also to make lower rates for transportation. If the system recommended by the commission could be faithfully adhered to for a few years, the river would be put in such condition as would induce the presence of steamboats and barges, so as to render it impossible for railroads to monopolize freights.



TOW AND BARGES ON THE MISSISSIPPI RIVER.

EARLY LEVEE BUILDING

BY WILLIAM BEER, LIBRARIAN, HOWARD LIBRARY, OF NEW ORLEANS

Whatever may be the relative merits of the different methods of controlling the current of the Mississippi in floods, it is clear that the levees are of the greatest importance to the agricultural and commercial interests of the whole valley of the Mississippi, and specially to that portion lying south of Cape Girardeau, in which the banks of the river are below the level of the flood.

The system has been the work of two centuries as the following brief record will show. It takes up the subject at the time when the word levee was applied to a loose and rapidly made embankment; protecting the infant village of New Orleans, not yet the capital of the vast and unknown territory of Louisiana, or surrounding the few cultivated acres of the industrious emigrants who had been attracted by the reports of the wealth of the colony.

The record runs to the opening years of the great struggle between the forces of the North and South. At that time behind their well-built and lofty ramparts were sheltered incalculable values of improved land cultivated by a million slaves, and producing crops of such market value that both the planter in the country and the merchant in the city were of princely wealth. On the first exploration of the lower Mississippi in 1684 by La Salle, he found the banks under water. In 1717 Bienville, coasting along the shore of Lake Pontchartrain, saw above the water the Metairie Ridge some six or seven feet higher than the general level, and, in consequence, decided on the present site for the foundation of New Orleans. The settlement he made in 1718 was greatly interfered with by the high floods of that year. For the protection of the infant city his engineer, Leblond de Latour, erected the first temporary levee which was finally completed by Governor Perrier in November, 1727. It was 5,400 feet long and 18 feet wide at the top. At the same time less important levees were constructed for about 18 miles above and below the city.

The country around New Orleans was thinly settled. The levees were much injured by the flood of 1735 which continued from December to June, 1736, and inundated New Orleans. This caused increased activity in levee building, and by 1736 they extended a distance of 42 miles, from English Turn to 30 miles above the city. The government issued an edict compelling owners of land on the river to improve their levees and have them in good condition by January 1st, 1744, under penalty of confiscation. Owing to the execution of this law Louisiana escaped with comparatively little damage from overflow.

In 1752 the levees had been built along the river front 20 miles below and 30 miles above New Orleans, from Concession to near Bonnet Carre. The levee system was excellent, and no breaks occurred. The government of the colony guarded the levees with efficiency. These were constructed by the planters themselves. The government reserved a supervisory power, allowed no planter to endanger the safety of his neighbors by neglect. All the land so protected was under cultivation; nearly the entire population of the colony lived along the river. The cost of levee building was so high that new land was only slowly cleared and improved. The levee, however, continued to advance slowly northward at the rate of a mile a year. In 1770 there was a flood of which no account remains, and in 1782 the Attakapas and Opelousas suffered severely. In 1785, 1791 and 1799 New Orleans was flooded. In 1796 the Teche country and in 1809 the plantations above Natchez were under water.

In 1812, the date of admission of the State of Louisiana to the Federal Union, on the east bank of the river, the levees extended a length of 155 miles to Bayou Manchac, and on the west bank to Pointe Coupee, a distance of 185 miles. The total length of levees in 1812, therefore, was 340 miles, which must have caused an expenditure on the part of the cultivators of at least $6,000,000.

Grand levee, which protects seven parishes from overflow, the largest and most exposed in the State, broke in 1813 and caused great damage. The river overflowed the basins of the Atchafalaya, Bayou Teche and Grand Lake. New Orleans suffered slightly from a cave 12 miles above the city.

In 1816 the Macarty levee broke for the second time and flooded to a depth of five feet the rear portion of the city.

In 1828 the line of levees was continuous from New Orleans to Red River Landing, just below the mouth of Red river, a distance of 195 miles, and for 65 miles below the city. Above Red river they were in an unfinished state to Napoleon. By 1844 the system was practically continuous to Napoleon.

The increased importance of the production of the valley was shown in the River Convention of 1845 at which it was recommended to Congress that Federal aid should be afforded to levee building and that the flooded lands of the basin should be given to the states for that purpose. The convention was not without its effect. Congress adopted a resolution authorizing a survey of the Mississippi for the purpose of ascertaining the best method of reclaiming alluvial lands, and in 1849 donated to Louisiana, to reclaim the swamps and overflowed lands there, the whole of these swamps and overflowed lands unfit for cultivation to aid in constructing levees.

In 1850 a similar donation was made to the State of Arkansas. The three States of Louisiana, Arkansas and Mississippi have thus received 18,545,270 acres of swamp lands.

From 1850 to 1861 with ample funds, the protection of the alluvial lands by levees proceeded with great activity and success. At the outbreak of the war in 1861 there was a continuous and stable line of embankments on the Mississippi river.

The authorities on the subject are the great work by Humphreys & Abbot, "Report upon the Physics and Hydraulics of the Mississippi river; upon the Protection of the Alluvial Region Against Overflow; and upon the Deepening of the Mouths; based upon Surveys and Investigations, Washington, 1876." An admirable article by Mr. Norman Walker in the report of Internal Commerce of the United States for 1887 and the pages of De Bow's Review.

ICE SCENE ON THE MISSISSIPPI RIVER OPPOSITE NEW ORLEANS.
REMARKABLE PHENOMENON OF THE WINTER 1898-99.

Leon Jastremski

DIRECT INTERCOURSE BETWEEN THE MISSISSIPPI VALLEY AND SOUTH AMERICA

BY GEN. LEON JASTREMSKI, OF LOUISANA
FORMERLY U. S. CONSUL AT CALLAO, PERU

Thirty-five years ago, the vast territory from which have been formed the States of North and South Dakota, Montana, Idaho, Wyoming, Colorado, Utah and Nevada, and the territories of New Mexico and Arizona, which are aspiring to Statehood, were included in what was then known as "the Great American desert." Communications with the Pacific Coast States were carried on by way of the Isthmus of Panama, the Straits of Magellan and around Cape Horn, or by caravans across the desert. In the interval, the wave of immigration has rolled across these vast areas, which were the abodes and hunting grounds of the Red Men. Railroads have connected the two oceans, and prosperous towns, cities and States, peopled by the irresistible white race, have sprung into active life. There are no more worlds to conquer within the vast domain of the Union. But the rapidly growing population, and the corresponding increase in the products of its industries, suggests the necessity for the opening of new fields or markets for their sale and exchange.

A mere glance at the map of the globe will suffice to indicate that the nearest, broadest and most natural field for the expansion of American commerce and enterprise, lies in the continent of South America. It must be obvious, too, to the commonest observer, that avenues for this expansion, other than the remote ones starting from our Atlantic and Pacific ports, must quickly be opened. This is the era of lightning speed on the shortest and most direct lines. Clearly, all of the States whose water courses flow into the Mississippi, must seek the markets of South America through the ports on the Gulf of Mexico.

During my sojourn in Peru I had the good fortune of profiting from the personal observations of an eminent American resident there, who had dwelt and traveled in the principal countries of South America; and, on a certain occasion, referring to the vast resources of this continent, this gentleman exclaimed: "You cannot overestimate the stores of wealth that South America possesses. Our people seem to have little knowledge of them, and I have come to the conclusion that the continent has to be rediscovered by our countrymen."

The Europeans labor under the disadvantage of having to cross the Atlantic ocean to reach this field, yet we have allowed them to get the bulk of the commerce of South America, to monopolize the navigation of its gigantic rivers and its coasts, to control the railroad across the isthmus of Panama and to undertake the work of cutting the ship canal through it. Shall we remain inactive and let them build its railway system while we boast of our ability to produce cheaper rails in our mills and rolling stock in our machine shops?

The continent of South America extends from 12 degrees north latitude, to 57 degrees south latitude; consequently it has a length approximately, of 4,150 miles. At its greatest breadth, it extends from 35 degrees to 82 degrees west longitude, and measures approximately, 2,800 miles. It has an area twice as great as that of the United States. Its population is not under 50,000,000. It possesses every climate, all species of plants and productions; all the precious and other metals and minerals; rare woods, dyes, exquisite fleeces and peltries, and throughout its immense tropical region it produces articles in profusion which are eagerly sought by the rest of the world. In its virgin forests and wilds it has been said by a famous explorer that there goes to decay on the surface of the ground enough riches annually to pay off the national debt of the world. Of this same region Humboldt also has said that it is destined to become the center of the population of the earth. It has climates on its Pacific coast which are unexcelled by any other favored region of the earth.

In its equatorial domains the tropical heat of the low lands is tempered by the sea or mountain breezes, while the altitudes afford climates of the temperate or frigid zones to suit the fancies of all men. It has scenery of unsurpassable grandeur and loveliness. It has glorious skies, majestic mountains and noble rivers, which are navigable for thousands of miles. It has great cities, centers of culture, refinement, luxury, pleasure and wealth. It has ever placid seas and deep harbors, and it has romantic traces of a civilization that had existed for centuries prior to the discovery of America by Columbus. It has histories replete with deeds of heroism, endurance and self-sacrifice, which rivaled those recounted by the histories of the Old World. If it has stories of frequent revolutions, it has stories, also of as many battles fought for liberty and the rights of man as the proudest of lands can boast of. It is a land of poetry, love and glory, and a land, too, of chivalric and scholarly men and lovely and beautiful women.

Reveling in the profuse natural riches of their land, the South Americans have not had to tax their energies as the less favored Europeans or North Americans have been compelled to do. Yet, they have neither been unmindful nor indifferent to the inventions and progress of other nations. Nowhere do enterprising, ingenious and resolute men receive more generous encouragement, and none such experience serious difficulties in obtaining the most liberal concessions to open lands to cultivation, navigate rivers, operate mines, or construct canals and railways. They are welcome everywhere, despite the many deceptions that have been practiced by charlatans and conscienceless fakirs.

The natural conditions in South America invite intimate intercourse with us. *The seasons beyond the equatorial line* are in reverse of ours. When it is winter there it is summer here, and were the means of communication adequate, the South Americans would come here for a change instead of seeking it in Europe. And our people might, with far greater profit to themselves and their country, visit in return the picturesque and attractive countries of the southern continent. Innumerable false impressions and prejudices would vanish on both sides of the line, and a new era dawn upon the twin continents out of such intercourse.

It is indisputable that our shortest and most practical line of penetration into South America is through Venezuela and Colombia, along the slopes of the Andean range, just where Pizarro made his marches of conquest, and where he found the empire of the Incas. That the Incas had chosen the best and richest domain of their epochs is proven by the still existing conditions, for the occupation of the great basin of the Amazon is yet most practicable from the chain of the Andes, where the United States surveyors have staked the Intercontinental Railway, which, be it said in passing, our people are allowing to slumber in company with the Nicaragua canal.

In these days commerce moves with steamships or railways, and as long as the United States do not provide them, the European steamship lines to Colon and around Cape Horn will take to Europe the trade of that region of South America which nature has placed within easy grasp of the American people.

A glance at the map shows that the Atlantic coast countries of South America are closer, perhaps, to Europe than to the United States. This justifies the preponderance of European commerce in these countries.

On the Pacific coast of South America the geographical position is reversed, since the capital of Peru, for example, is on *the same longitudinal line as Washington city*. It, and its seaport, Callao, whence a railway line pierces the Andes and descends towards the boundless valley of the Amazon, are distant but 1,500 miles from Panama.

It takes the Colombian Line steamers more than six days to carry the United States mails, freights and passengers from all the States east of the Rockies, from New York to Colon. In less than four days steamers could go from New Orleans to Colon.

Obviously the general trade interests of our country would seem to suggest the dispatching of the mails, freights and passengers from the Eastern States, as at present, by the Colombian Line from New York to Colon, and the mails, etc., from the north, west and south via New Orleans.

San Francisco mails are carried by rail to New Orleans in less than four days. As steamships can go from New Orleans to Colon in less than four days, it follows that San Francisco fast mails could be conveyed this way to Panama in eight days. It now takes San Francisco mails twenty-two days to reach Panama by the Pacific mail steamers.

The following table of distances will best illustrate the foregoing:

	Miles.
Callao to Colon	1,550
Colon to New Orleans	1,350
Total	2,900
Callao to Colon	1,550
Colon to New York	2,026
Total	3,576
Callao to Panama	1,500
Panama to San Francisco	3,800
Total	5,300
Callao to Colon	1,550
Colon to principal European ports	5,500
Total	7,050

The difference in favor of the United States ports is seen at a glance.

With an enterprise worthy of imitation, some seventy European steamers ply between European ports and Colon.

Among these a Liverpool line (the West India) has steamers which, on their return trips, stop at New Orleans to complete cargo, but which, on their way out, do not stop at New Orleans. The effect is obvious. New Orleans, the nearest American seaport—which is the natural outlet of the great valleys of the Missouri, the Mississippi and the Ohio—is left undisturbed in its strange isolation from the South American countries on the Pacific ocean.

It is to be considered that from New Orleans mails and passengers could be conveyed by rail to Washington in thirty-six hours; to New York in forty hours; to Chicago in thirty hours; and to San Francisco in less than four days.

Mr. James Bryce, the profound observer and thinker, says in his famous "American Commonwealth":

"The fate of western South America belongs to a still more distant future, but it can hardly remain unconnected with what is already by far the greatest power in the Western Hemisphere. When capital, which is accumulating in the United States with extraordinary rapidity, is no longer able to find highly profitable employment in the development of western North America, it will tend to seek other fields. When population has filled up the present territory of the United States, enterprising spirits will overflow into undeveloped regions. The nearest of these is western South America, the elevated plateaus of which are habitable by northern races. It may be conjectured that the relations of the vast territories in Ecuador, Peru and Bolivia, for which the Spaniards have done so little, and which can hardly remain forever neglected, will one day become far closer with the United States than with any European power."

Owing to the unavoidable curves that the railways make through Texas and Mexico, the connection that will be made at or near the Isthmus of Panama with the projected Intercontinental Railway, will always be quicker, cheaper and shorter by sea from New Orleans, and the directors of the railways centering there cannot fail to perceive that steamships connecting New Orleans with South America would operate practically as extensions of their lines into South America. In my judgment the first line of steamers should be established from New Orleans to Colon and other ports in Colombia and the Venezuelan port of Laguayra. They should make close connection for the transferring of passengers, mails and freights with the steamers at Panama bound for the ports of Colombiac, Eucador, Peru and Chili, to the southward, and the ports of Central America, Mexico and California, to the northward. The vessels should be first-class in speed and accommodations, and backed with sufficient capital to satisfy the public that they will stay in the trade, for it cannot be reasonably expected that the established currents of trade will be diverted by vessels sent out for one or two tentative voyages. As the United States mail service with the Isthmus is one of the obstacles to enlarged intercourse with South America, no difficulty should be experienced from our government in obtaining mail contracts for the lines referred to, which would enable all of our territory west of the States of the Atlantic seaboard to have direct and speedy *mail communications with South America, through New Orleans.* It would then become practicable and advisable for our express companies to establish agencies in all the countries which could be reached by the new and shorter line, and for American commercial houses or limited stock companies, to open branches or stores there. Quick and regular voyages, good accommodations, at reasonable rates, and excursion facilities both ways, would develop an intercourse of surprising dimensions, of people from both continents on business or pleasure bent.

This trade movement southward should never cease until a steamship service is established in the Gulf of Mexico, greater in importance to New Orleans than was the steamboat service on our rivers prior to the railway era. When it is remembered, for example, that the voyage by steamer to Shreveport took longer, was more dangerous and the running expenses of the steamers far greater than would be the steamship navigation on the Gulf, is it not passing strange that the latter is scarcely beyond the embryonic stage?

New Orleans is the nearest American seaport to the Isthmus of Panama and to South America. It has an ancestry and a colonial history in common with the Spanish-American countries. There are striking similarities between the Creoles of New Orleans and the Creoles of Spanish-America, and the latter would find in the architectural and other features of our Creole quarter, and in the tastes, customs, manners and instincts of its inhabitants, much that would be congenial, and would remind them of their own land. No other city in the United States is so felicitously adapted to lead in the great movement which is destined to weave the ties of fraternity, common aspirations and commercial intercourse between the twin American continents. Everything in existing conditions suggests this forward movement. No other great seaport presents the unique spectacle that New Orleans does towards the countries beaten by the waves of the Gulf of Mexico. It might be likened to Marseilles, communicating with Cairo and Constantinople, through Havre and Bordeaux; Liverpool with New York, through London, and Oporto with Havana, through Barcelona.

There may be comfort in the thought that many interior commercial and manufacturing centers, which are seeking new markets in Latin America, likewise pay tribute to the longer route via New York. It may be that these centers have not yet discovered that New Orleans is 700 miles nearer to the Isthmus of Panama than New York. For example, via New Orleans, Cincinnati would save 627 miles; Indianapolis, 689; Chicago, 700; Duluth, 750; St. Paul, 754; Omaha, 1,032; Kansas City, 1,207; St. Louis, 1,058; Louisville, 841; Nashville, 1,073; Knoxville, 883; Chattanooga, 1,059; Atlanta, 1,081; Memphis, 1,462.

An examination of the map of the world and of the locations of its seaports will readily disclose the incontestable fact that of all her rivals in the maritime trade, New Orleans possesses, beyond any comparison, the greatest natural advantages. No other seaport in the world has for feeders to its trade as many miles of river navigation at its back as New Orleans possesses in the great waterways system of the Mississippi valley, and the day is at hand when, by means of the Hennepin canal, the chain of our northern lakes will be joined for practical uses to the river system, for which New Orleans is the natural outlet. For her railway facilities, New Orleans has some of the leading air lines from the Gulf of Mexico to the northern boundary of the United States, and she stands on perhaps the greatest and most important transcontinental railway that joins the Atlantic to the Pacific. It is almost needless to add that these lines intersect the entire railway system of the United States.

Toward the gulf, at varying distances of but a few hundreds of miles, New Orleans has at her right hand the entire coast line of Louisiana, Texas, Mexico and Central America, while at her left hand, and about equidistant, is the coast line of Mississippi, Alabama and Florida, and the whole archipelago of the West India Islands, in which Cuba, Santo Domingo, Haiti and Jamaica are to be included. But by far grander, and due south, at no greater a distance than 1,300 miles, lies the marvelous continent of South America, with its superb rivers, mountains and valleys, its wealth of precious and other minerals, its forests teeming with undisturbed woods and glorious vegetation, its magnificent cities, its varied climates and dazzling scenery, its population of 50,000,000, its capacity to accommodate eight times as many more, with a corresponding development of its already great trade and industries, eagerly awaiting the coming of the reputed unrivaled American enterprise. All this and much more than the pen can describe, faces New Orleans, and through New Orleans the great Yankee nation, for whose smelters and workshops and for whose surplus of machinists and skilled artisans and other classes of work and money seekers, South America offers a broader field than any other division of the globe.

New York, on the Atlantic side, is over 2,000 miles from the Isthmus of Panama, and San Francisco, on the Pacific side, is nigh on to 4,000 miles from the same isthmus. New Orleans is only 1,300 miles from it, and, therefore, has the advantage of 700 miles in distance over New York, and more than 2,000 miles over San Francisco, in the competition for the trade and intercourse with the Pacific coast of South America, that is to say, with Colombia, Ecuador, Peru, Bolivia and Chili, whose combined population exceeds 12,000,000, and whose actual trade and industries, already very great, are susceptible of a four-fold development by means of an isthmian canal in a very few years.

Obviously, the Pacific and northern sides of South America offer to the people of the Mississippi Valley the greatest inducements. Undisputably, too, the line of penetration from the United States into South America is along its western side, the Pacific ocean, for navigation, and the eastern slopes of the Andean chain for the Intercontinental Railway, which would give our people an inland route through the heart of South America, where its greatest undeveloped riches and opportunities lie, all the way to the magnificent city of Buenos Ayres, so aptly called the Paris of South America. In passing, it may not be amiss to remark that the line of the intercontinental was surveyed some years ago, at United States expense, by a corps of American engineers, who reported the project entirely feasible, and at a cost approximating $100,000,000.

American effort should be directed primarily to the construction of the isthmian canal, to the end that American shipping from our Atlantic and gulf ports may then strike for the overflow of European steamship monopolies which are controlling the trade of the Pacific coast of South America, and to a considerable extent the trade, too, of the western coasts of Central America and Mexico.

But American effort should not wait until the completion of the isthmian canal to attack the trade to which I have adverted. It should establish direct lines of first-class steamships between New Orleans and the leading ports of the north coast of South America and with the Isthmus of Panama, there to connect with the Panama Railroad. Furthermore, as a regulator of charges by the Panama Railroad, American capital should help to complete, and, if possible, gain control of the short interoceanic railways across Costa Rica, Honduras and Guatemala; and the Isthmus of Tehuantepec, in Mexico. By these means the American steamship lines, which should be promptly established, would have no less than five competing short interoceanic railways over which to wrestle for the trade of the Pacific coasts, with the European lines now acting in co-operation on both oceans against American trade progress. These American steamships would be ready for the direct trade through the canal upon its completion.

Once, New Orleans was considered one of the leading coffee importing markets in this country, and it is stated that coffee imports from Brazil and other countries to New Orleans, reached 550,000 sacks annually. Now, in 1896, the steamers of the Pacific Mail Company, plying between San Francisco and Panama, carried to the latter port no less than 564,000 sacks of coffee from the Pacific coast of Mexico and Central America. With the exception of 74,000 sacks which were carried to New York, the rest, amounting to nearly 500,000 sacks, were carried to Europe by means of the Panama Railroad and the lines connecting Colon with Europe. Not a single sack of this coffee went to New Orleans. Besides, it is authoritatively stated that tramp steamers carried directly to Europe around the straits of Magellan at least 500,000 more sacks of this superior coffee. It is obvious that with something like the proper degree of enterprise, New Orleans ought to get this million of sacks of coffee with which to double its biggest coffee trade, and this without drawing a single sack from Brazil.

The absurd policy that our trans-continental railways have stubbornly pursued has turned over well nigh bodily the vast trade of the Pacific coasts of Mexico, Central and South America to the Europeans. Forgetting that Boston, New York and Philadelphia are 2,000 miles nearer Panama than is San Francisco, these lines have endeavored to carry the trade from the Eastern cities across the continent by rail, a distance of 3,500 miles, to San Francisco, where in starting for South America this trade would be 2,000 miles farther than it was at the point of departure. If we would command the trade of South America, American goods and travel from the eastern ports must go directly from these ports to South America. The trade and travel from the territory that is tributary to the Mississippi, including the northern lakes, must make their way by the waterways of the valley, and by its railways, to the gulf ports, thence to the markets of South America. And the trade and travel nearest to our Pacific coast must make their way southward from the ports on that coast. That is the natural order. Then, from every port of the Union, American trade and intercourse will flow into South America, by the shortest and most direct routes, and European competition will be unable to resist so formidable and general an advance into the territories that American purblindness has permitted it to monopolize.

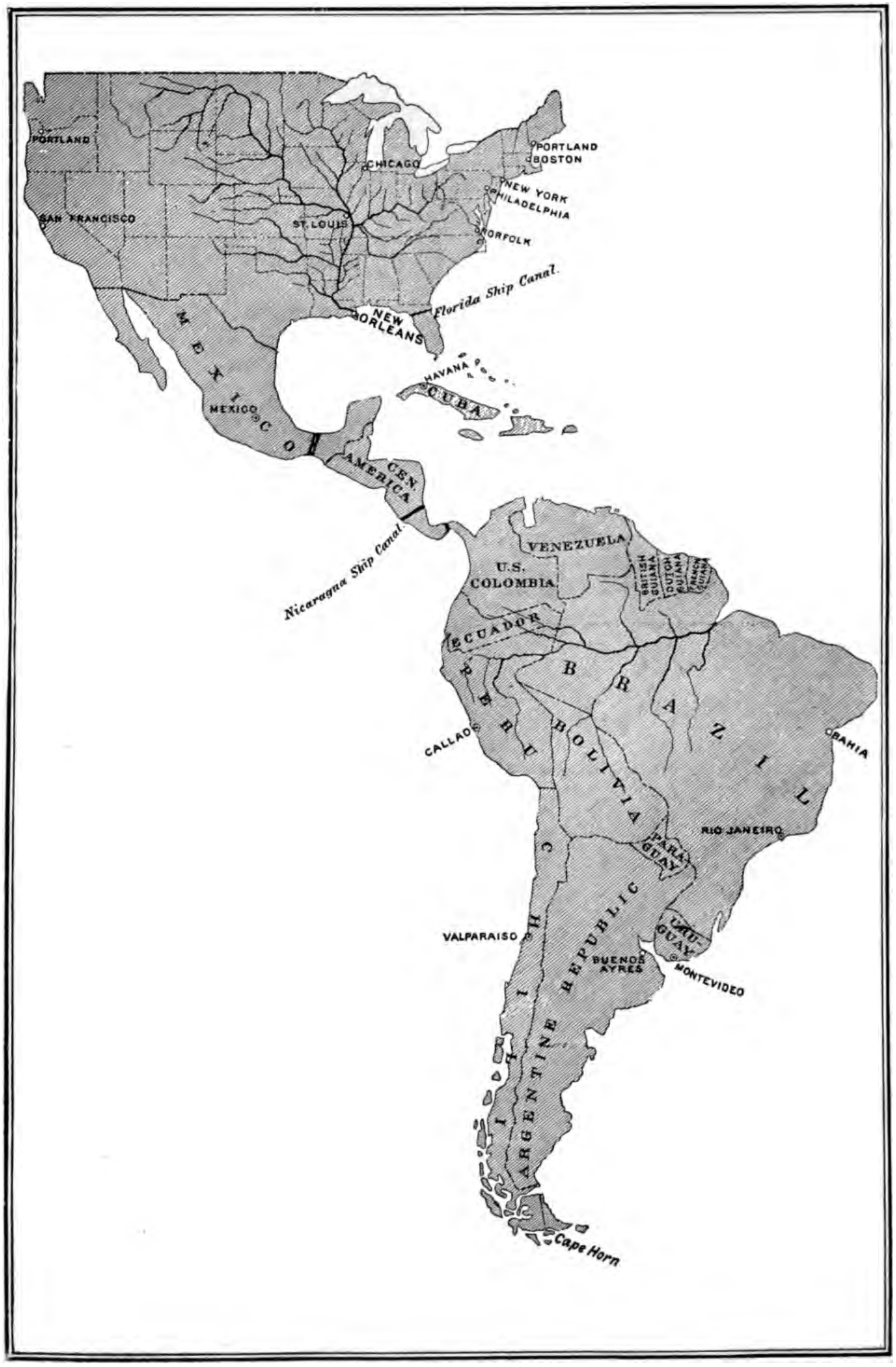
I have seen American war vessels pay $15 per ton for English coal at the port of Callao. Think of the effect of Ohio river and Alabama coal going in sea-going barges through the isthmian canal, to Callao, upon the English coal brought in ships around the straits of Magellan, from England.

What of the light draft steam vessels that with the deepening of the channels of the Mississippi and its tributaries, including the Hennepin Canal, will then be able to transport directly to the Pacific ports of Mexico, Central and South America, American goods from Chicago, Cincinnati, Louisville, Kansas City, St. Louis and Memphis.

These will be the effects of the improvement of the waterways of the Mississippi valley, the deepening of the passes to our gulf ports, the digging of the Nicaraguan Canal, the building of the short railways across Central America, and of the grand culmination, the construction of the intercontinental railway from the shores of the Caribbean Sea to Buenos Ayres.

TOW AND BARGES OF PITTSBURG COAL
The Future Source of Supply of the South American Ports

RELATION OF THE MISSISSIPPI RIVER TO SOUTH AMERICA



MOUTH OF THE MISSISSIPPI RIVER

LETTER OF

COL. B. M. HARROD, MEMBER OF MISSISSIPPI RIVER COMMISSION

AND

MAJ. HENRY B. RICHARDSON, CHIEF STATE ENGINEER OF LOUISIANA

NEW ORLEANS, February, 14, 1898.

SENATOR KNUTE NELSON, *Chairman, The Sub-Committee on the Mississippi River of the Committee on Commerce, United States Senate:*

The contract between the United States Government and James B. Eads calls for the following channel depths and widths:

From deep water in the river above the Head of the Passes into and through South Pass, 26 feet of depth, of a navigable width.

Through the jetties, 200 feet wide and 26 feet deep, with a central depth of 30 feet.

Over the bar, at the sea end of the jetties to deep water, 200 feet wide and 26 feet deep, with a central depth of 30 feet.

These channel dimensions were sufficient for the fleets of commerce of 1875, composed of vessels rarely exceeding 300 feet in length and 25 feet in draft.

At the present day many ships are built 600 feet long, with a draft of 30 feet, and it is certain that these dimensions will be materially exceeded in the near future.

We assume that it is the intention of the Government to open the mouth of the Mississippi River to every ship in the world that seeks it on a peaceful errand.

We submit that the minimum channel dimensions now necessary to afford this facility to commerce are as follows:

From deep water in the river into the selected pass, a depth of 32 feet, 500 feet wide, within which width an intermediate depth greater than 32 feet would be developed. These dimensions should be carried through the pass and jetties to a point where the swell of the sea is felt, and from this point, the depth of 32 feet, 500 feet wide, should be gradually increased to 35 feet, with the same width, at and over the bar at the sea end of the jetties, with such greater intermediate depths as would be developed. These dimensions should be secured at all stages of the tide and river.

We are of opinion that it would not be practicable, and, if practicable, would not be economical, to enlarge the South Pass and jetty channel sufficiently to obtain these dimensions. The difficulties would be both in securing the enlargement of the waterway and in preserving the integrity of its banks.

We submit with this communication a diagram showing the relative sizes of the channel as now required by law, through South Pass, and of such a channel as is required by the commerce of the present day.

It will be observed that the cross-sectional enlargement called for requires the removal of 557 cubic yards per linear foot, or 34,000,000 cubic yards for the entire length of 12 miles of South Pass. An increased width of channel at the head of the pass and between the jetties would also be necessary, involving the practical reconstruction of these works at both its ends.

The removal of such an enormous mass of material as above indicated from the channel of South Pass, by whatever means accomplished, would of itself plainly involve large expenditures of money and probably require a greater length of time than other parts of the work of improvement; while the necessary reconstruction, or at least remodeling, of the jetties and other works at its head and mouth must form a large share of the cost of any plan for its further improvement.

To sufficiently increase the navigable depth of South Pass without at the same time unduly increasing its width at the expense of its existing natural banks, appears to us a difficult and doubtful undertaking. That it could be so done as to secure an adequate channel for the commerce of the near future without extensive and costly works for the revetment of the banks, so as to prevent their being generally cut back into ground too low to retain the water in the pass, or in some places breached altogether, is, at least, a matter of grave doubt, although of vital importance.

Moreover, it is by no means certain that the work of improvement could be carried on without greatly obstructing the navigation of the pass during its progress.

We are of opinion that such an outlet as the commerce of the Mississippi River and its tributaries now demands can be most surely and economically obtained by the improvement of the Southwest Pass by means of jetties. The requisite width, depth and proportion of discharge already exists into and through that pass, excepting the 30-foot shoal in the Mississippi River between Cubits Gap at the Head of the Passes. This obstruction is common to all passes, and must be removed whichever one is selected for improvement.

The velocity of flow in a stream varies directly as the square root of the product of its hydraulic radius (or ratio between the sectional area of the part of the bed it occupies and the frictional or resisting surfaces bounding it) by its slope (or the ratio between its fall and length). As the excess of the hydraulic radius of the Southwest Pass over that of South Pass is greater than the excess of the slope in South Pass over that of Southwest Pass, and as the scouring power increases with the depth and volume it is reasonable to expect that the greater volume flowing through Southwest Pass will, notwithstanding its lesser slope, give it a velocity and scouring power at least as great as that of South Pass. How much greater can only be determined by survey.

We have had neither occasion nor opportunity to make an estimate of the cost of the improvement of Southwest Pass. Undoubtedly it would be considerable, but not disproportionate to the object in view.

We believe, however, that many of the predictions as to the first cost and the difficulty of maintenance have been exaggerated. It is of record that the increased rate of advance of the South Pass bar which was anticipated as the result of the building of jetties, both by the opponents and advocates of the project, has not been realized. On the contrary, it has been retarded rather than accelerated. The natural annual extension of the South Pass bar seaward was about 100 feet per year before 1875. General Humphreys, a then chief of engineers, predicted that this rate of advance would be, by the building of jetties, increased to 670 feet per year (Rep. Chief Engineers, 1874, p. 867). General Newton, a member of the "board of engineers on the improvement of the passes as an alternative to or in connection with the Fort St. Philip Canal," which reported adversely to jetties, estimated the annual advance of South Pass bar, after the construction of jetties, at probably 2,240 feet, or at least 1,500 feet (pp. 884-885 of same report).

The Board of Engineers which advised the improvement of the South Pass Bar by jetties, composed of three United States engineers, three civil engineers, and one member of the Coast Survey, were of the opinion that "in an average of many years the rate of progress must be about the same as now, namely, 100 feet per annum," but they assumed that the jetties would have to be extended 1,000 feet in ten years. (Report Chief Engineers, 1875, p. 954.)

It is needless to say that neither the apprehensions of the increased rate of bar growth nor of the necessity of jetty extension have been realized.

We append the average rate of seaward extension of the South Pass Bar since the completion of jetties for every curve of depth from 20 feet to 100 feet, and for the nineteen years from 1876 to 1895. It will be remembered that the growth before the jetties were built was 100 feet per annum.

The curve of 20 feet depth has advanced 33 feet per year; 30 feet depth, 54 feet; 40 feet depth, 48 feet; 50 feet depth, 58 feet; 60 feet depth, 86 feet; 70 feet depth, 68 feet; 80 feet depth, 83 feet; 90 feet depth, 89 feet; 100 feet depth, 86 feet. (Rep. Chief of Engrs., 1896, App. Q, Pl. 1.)

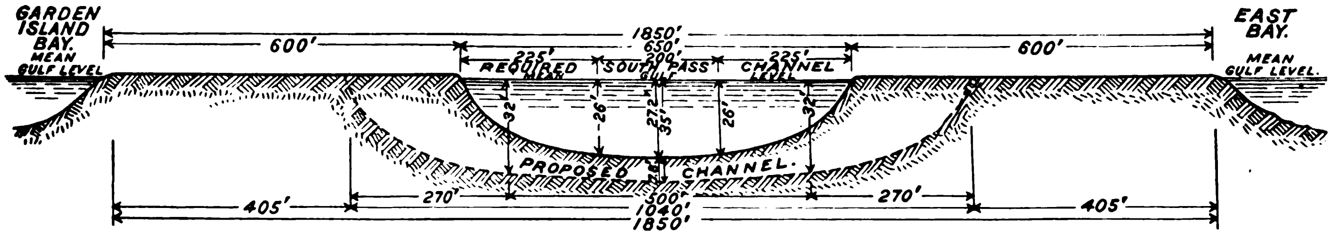
It will be seen from these figures that the average annual advance of the bar has been only about 65 feet, or less than two-thirds the previous rate, and that the curves for 20 feet, 30 feet and 40 feet depths, with which navigation is immediately concerned, have only advanced, on an average, 45 feet per annum, or less than half the general advance of the bar before the construction of the jetties.

It was observed that the building of the jetties at the Sulina mouth of the Danube Delta retarded instead of accelerating the growth of the bar at its mouth. Sir Charles Hartly, the engineer of the improvement, attributed this to conditions which also prevail to a greater or less extent at the mouth of the South and Southwest passes of the Mississippi. Under these circumstances there is no reasonable foundation for apprehensions of an excessive or extraordinary increase in the annual rate of extension of the Southwest Pass Bar when improved, or of the jetties which should be built across it.

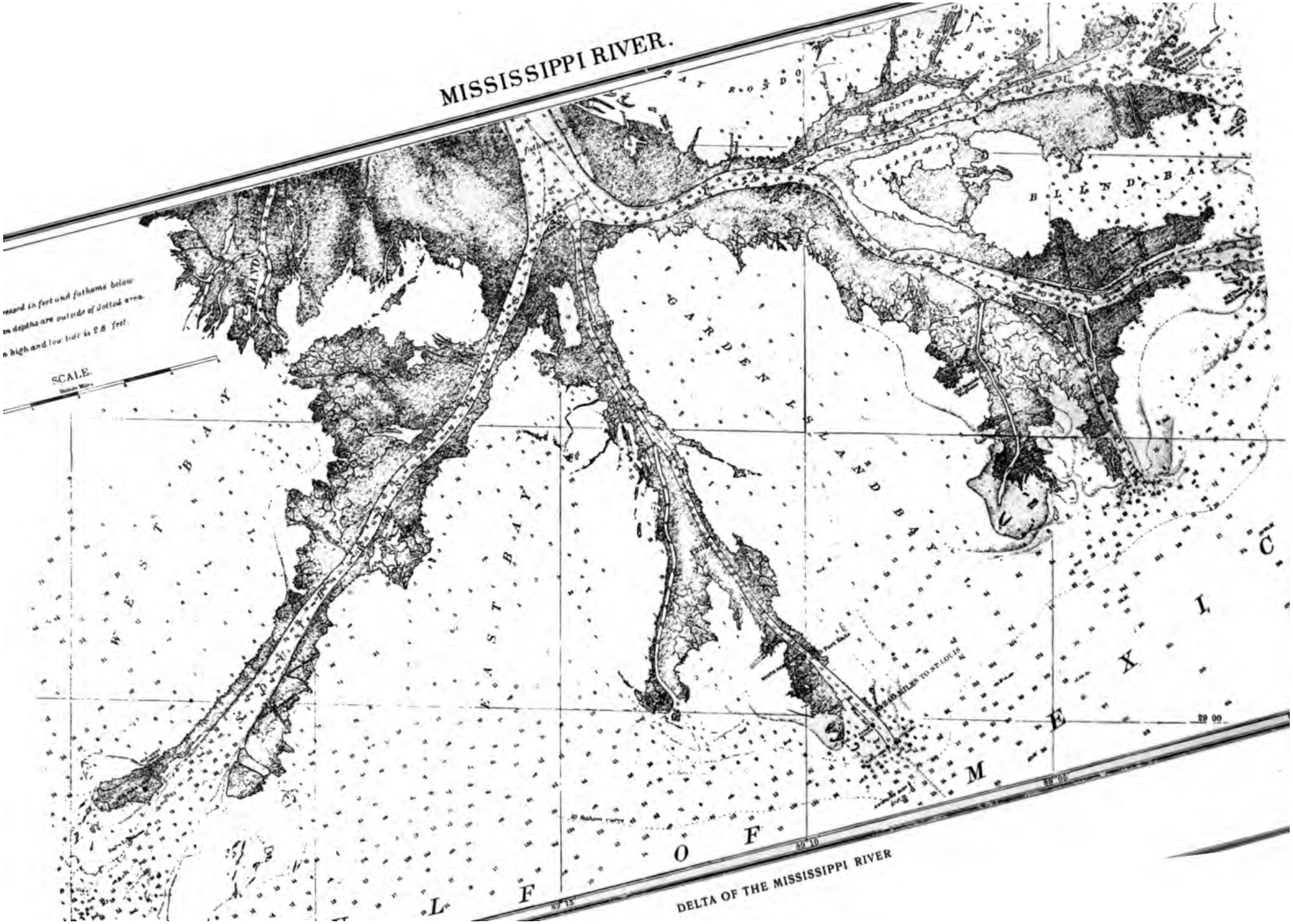
Respectfully submitted:

B. M. Harrod, C. E.,
Member Mississippi River Commission.
Henry B. Richardson,
Chief State Engineer, Louisiana.

PRESENT AND PROPOSED CHANNELS



	Sq. feet.
Cross section of south pass from Garden Island to East Bay, solid line—cross-sectional area	13,120
Required channel for commerce of the port of New Orleans, dotted line—cross-sectional area	28,270
Difference of cross-sectional area	15,150


MISSISSIPPI RIVER.
BAY RONDO
JACKSON'S BAY
BLIND BAY
GARDEN ISLAND BAY
EAST BAY
WEST BAY
GULF OF MEXICO
MILES TO ST. LOUIS
10 fathom curve
29 00
29 05
29 10
29 15
…asured in feet and fathoms below
…m depths are outside of dotted area.
…n high and low tide is 2.8 feet.
SCALE.
Statute Miles
DELTA OF THE MISSISSIPPI RIVER

MAJ. JAMES B. QUINN, U. S. A.

MOUTH OF THE MISSISSIPPI

HISTORY OF ATTEMPTED IMPROVEMENTS

BY MAJOR JAMES B. QUINN, CORPS OF ENGINEERS, U. S. A.

Standing upon the bank of the Mississippi river at New Orleans one is impressed with the vastness of its flood and the presumptively great periods of time covered by the progress of the delta which characterizes its issue into the Gulf of Mexico. To what races of men has its existence been known? Our acquaintance does not cover many years, it is true, but the natives who occupied the land before the advent of the white man point to the various mounds of earth which are found at numerous places throughout southern Louisiana as the constructions of a race extinct for so great a time that among them there exists no traditions concerning this race of people who have disappeared, and who must have possessed some degree of civilization, as the pottery, relics and stone implements found in the mounds bear witness.

It is reasonable to suppose that at some distant time in the past the mouth of the river was in the immediate vicinity of New Orleans, yet to-day it is fully 112 miles by river to the sea, and fully 45 miles below New Orleans an Indian mound exists, which must certainly have been built some distance from the mouth, if the marshy and low condition of the land existed then, as now, in that vicinity.

There is one remarkable circumstance connected with the flow of the river, and that is the persistency with which it adheres to the channel which it has scoured out for itself. Crevasses occur in its banks, and the volume of water escaping is sufficient to cause one, for the time, to believe that the river has changed its course; but in time the crevasse ceases to be other than an insignificant stream or ceases to flow entirely. Although the river may change the location of its bed sometimes by cutting out upon one side and filling in upon the other, or cutting through bends and forming cut-offs, the continuity of the stream is rarely interrupted. Such interruptions have, however, occurred in modern times, as in the vicinity of New Madrid, where the channel was changed by reason of an earthquake; and the peculiar bends at what is known as English Turn, below New Orleans a short distance, when taken into consideration with the peculiar formation of the land between Lake Borgne and Chandeleur Sound, might lead to the inference that at some time the mouth was not far from the Chandeleur Island, and that the present channel was created through the action of some earthquake, which forced the stream to the westward for a short distance and then permitted it to erode or create the channel which it now pursues.

There are not lacking evidences of seismic action within the limits of the city of New Orleans, since recent excavations have brought to light the stumps of cypress trees which at one time stood in fresh-water swamps above the level of the Gulf, but which are now as much as 14 feet below this level, their preservation and general appearance indicating a sudden subsidence.

Some influences are always at work to direct the course of the river in building the earthen trough which forms its channel. The water is at times heavily charged with sediment, and this sediment is borne along with the current or abandoned in part as the current slackens; but in the end it finds a resting place in the swamp bordering the stream, where the banks are not high enough to prevent overflow, or it is dropped near the point where the river water meets the sea water and builds up at this place a bar, the depth of water upon which is invariably slight compared with the depths in the main body of the river.

The manner in which these bars form and extend influences the general direction which the main body of the river ultimately pursues. Invariably numerous branches form in the immediate vicinity of the mouth. These branches are known as "passes," and spread out like the fingers of the hand when distended. Each of these branches performs its office of filling in the watery spaces on either hand, and they advance, or silt up, as the conditions of the river at the point whence they ramify changes. The area included in their ramifications is called the "Delta," and this formation is characteristic of all silt-bearing streams which debouch into seas.

To-day three passes branch from the main body of the river and form an extensive delta; yet if you retrace your steps along the bank of the river to New Orleans you will probably not be able to discover any points, except such as have formed in recent times, where you would be certain that a delta existed at any time. Is it possible that this river in its youth flowed into the sea without a delta? If so, it must have been a vigorous stream compared with what it is to-day.

The first pass which is noted as giving proper depth over its bar for the passage of vessels was Southeast Pass, which is now a very insignificant pass indeed. Then navigation, after a time, deserted this pass and sought other passes, as Pass a Loutre and Southwest Pass, at which passes there seemed to be alternations of favor, as their bars deepened or shoaled. With increasing needs for greater depths of water, efforts were made to improve these passes; and, first, there was tried the method of stirring up the bottom with harrows, which was moderately successful in securing a slight increase. Then an attempt was made to combine jetties with the stirring-up process. This failed, for the reason that the jetties were entirely too frail, and did not extend far enough to produce much effect. During all this time the necessities of commerce grew with far greater strides than the efforts to maintain adequate depths.

It took great efforts on the part of the people to secure sufficient funds with which to redouble the efforts to secure greater depths with improved dredging devices, and yet, with powerful dredging machines, the maintenance of a channel with as little as 20 feet depth was ineffective. Boards were created to report upon the subject, and much thought was expended upon the consideration of the various projects promising relief. The theories under which the bar formations occurred were fiercely debated, and the permanency of works at the mouths of the passes, and their adequacy, was thoroughly discussed. But at the root of all the propositions there was invariably found this recommendation: That the full amount of money required to effect the improvement should be at once appropriated.

As the estimated costs of any of the proposed improvements represented a vast sum at that particular time, when river and harbor improvements were in their infancy, it seemed that any relief was impossible, since Congress feared to take the responsibility for making such enormous appropriations for one locality. At this juncture there appeared a patriotic individual who seemed to appreciate the difficulties of the situation, and with a courage born of his convictions he proposed to Congress to do the work if he were to be allowed to follow out his ideas without restrictions, payments to be made to him as certain results were attained. There was fierce opposition to his proposition in certain directions, but the proposition possessed peculiar fascinations for Congress, if for no other reason that it solved the financial problem and promised permanent results. Above all things, it presented the element of economy and if applied at a smaller pass than that proposed, as South Pass, where it was believed satisfactory depths and widths of channel might be secured for a considerably smaller sum than it would cost to obtain parallel results elsewhere, all adverse criticism would be stifled.

Mr. Eads certainly deserves great praise for the able and successful manner in which he gained his point, although he did have to accept the smaller pass. His troubles had, however, only commenced, because he did not possess the private fortune necessary to carry on the work to the point where returns might be expected. He had promised much, and there were many who felt positive he could not accomplish all he promised. Outside assistance could not be obtained without paying great premiums, and many physical difficulties were experienced which were not anticipated. The much-vaunted claim that the channel, if properly constructed, would, unaided by dredging or other stirring-up processes, sufficiently strengthen the current to scour out the bottom with great rapidity was not fully realized, and dredging was found to be necessary; but the people were disgusted with the dredging operations to secure proper channels through the bars, and the necessity for dredging weakened confidence in the undertaking. It required extraordinary exertions on the part of Mr.

Eads to restore confidence and prove, in face of the fiercely contested claims that the bar would advance with greater rapidity in consequence of the jetties than before, that no advance of the bar had taken place as intimated.

Mr. Eads's perseverance under such adverse circumstances is truly remarkable, and although he did go to Congress and secure material concessions relative to channel widths and depths, and methods of payment, he certainly succeeded in giving to commerce a far better channel than was deemed essential, although not equal to that promised, and which has lasted fairly well up to the present time.

The theories propounded for the explanation of the growth of the bar at the mouth of a pass, as Southwest Pass for example, are chiefly stated in Humphreys and Abbot's Physics and Hydraulics of the Mississippi River. Briefly stated, the bar-building material consists of two varieties of earthy matter, that which is in suspension, and that which is pushed along the bottom. When this material reaches the sea end, it is deposited, owing to the loss of current in the stream which transports it. The volume of water issues in a fan shape from the channel formed by the banks. Its energy is dissipated upon coming in contact with the salt water, which opposes its exit, and the material which is carried along the bottom is soon brought to rest, while the lighter portion, held in suspension, is widely disseminated (owing to the fresh water gliding on the salt) and is deposited at much greater distances from the mouth. The material held in suspension forms, therefore, the foundation upon which the weightier particles are eventually placed.

The loss of energy, due to the resistance of the denser salt water and the lateral expansion of the stream, causes the shoaling of the water, and the depth of water maintained upon the bar is the result of an equilibrium between the eroding and depositing forces of the current. The form of the bar is greatly influenced by several forces, such as winds, waves, and countercurrents. If a current flows from left to right across the mouth of the pass, looking seaward, the material will be deposited in a greater quantity on the right-hand side of the pass, and vice versa. If the winds influence the countercurrents, then the direction of the prevailing winds will determine upon which hand the greatest deposits will occur. The waves have a tendency to flatten the bar and fill up all channels across it. The seaward slope of the bar is greatly influenced by the combined action of the currents and waves, being steeper on the side from which the currents come. If the effects of the countercurrents are not continuous, the result is that the channel across the bar is more or less deflected by the deposits on the side opposite that from which the currents arrive, and is more or less inclined toward the side from which the countercurrents proceed, or against the countercurrent. The advance of the bar will not be symmetrical with the axis of the pass. If, however, the countercurrents are feeble, the advance of the bar will be more or less symmetrical with respect to this axis.

If the spreading of the water can be prevented until the crest of the bar is reached, the current will be sufficiently strong, generally speaking, to project the material conveyed by it to some considerable distance beyond the point of issue; the deposit necessarily takes place in deep water, and a considerable time must elapse before the normal conditions are restored. The natural rate of progress of the bar does not give a proper conception of the time which will be required to bring about a restoration of normal conditions after the confining of the issuing water has been effected. In the first place, the point at which the normal crest of the bar must form will be in very deep water, and all the areas in advance and latterly must be filled up before this bar will be able to maintain itself. Secondly, this bar will build up faster, for the reason that the heavy matter is deposited over a shorter arc.

If a countercurrent sweeps across the axis of issue, much of the bar-building material will be deflected to one side and the advance of the bar will be retarded, but the direction of the entrance will be changed, since the channel through the new bar will incline toward the point of direction whence the countercurrent arrives, in which case the subsequent prolongation of confining works, or "jetties," as they are called, would be at an angle to the original line, and give rise to irregularities of channel between them.

When the advance of the bar is symmetrical the restoration of normal conditions is much more rapid, but the prolongation of the jetties is apt to be much simpler.

The improvement of Southwest Pass involves some considerations not heretofore fully touched upon. The character of the bar is somewhat different from the other passes. Numerous mud lumps arise at times, some of these directly in the channel. These lumps introduce complex conditions at times, by stopping the regular flow of the water and so causing deviations of currents and abnormal deposits. The stability of any jetty construction is imperiled by these strange formations. To predict just what is going to happen in such a locality is impossible, and all estimates for improvement have to have a large margin for contingencies. The efforts of all former improvers were futile for the reason that insufficient funds were provided to make all work secure against all circumstances. To simply rely upon dredging at such an exposed place is futile, if any considerable increase of depth is desired. To rely upon construction works unaided by dredging is simply to invite disaster, since a single mud lump arising in the middle of the channel would block everything for a long time. It would undoubtedly have to be removed by dredging. A combination of dredging and contracting jetties promises the only solution of the problem of securing and maintaining deep water at this entrance to the Mississippi River for a profitable interval of time.

In this connection it may be well to review at length the various attempts made to improve Southwest Pass, and endeavor to ascertain the causes and conditions which determined success or failure.

The first appropriation for the improvement of the entrance to the Mississippi River was made in 1837, and upon the recommendations of a Board of Engineers an attempt was made to open the Southwest Pass by using the ordinary bucket drag. No permanent improvement was effected, as a single storm sufficed to obliterate all the work which had been done. Nothing further was done until 1852, when an appropriation of $75,000 was made for opening "a ship channel of sufficient capacity to accommodate the wants of commerce;" and it was further provided that the said money should be applied by "contract," and that the contract should be "limited to the amount appropriated." A mixed naval and engineer Board was convened by the Secretary of War to decide how the appropriation should be applied. This Board consisted of Commodore W. K. Latimer, United States Navy; Maj. W. N. Chase, United States Engineers; Maj. G. T. Beauregard, United States Engineers; and Capt. J. G. Barnard, United States Engineers; all of whom had served on the Gulf coast.

This Board reported that no other plan seemed capable of obtaining any important results than that of "stirring up" the bottom, and in accordance with this report a contract was entered into with the towboat association, by which a channel through the bar of Southwest Pass, 18 feet deep and 300 feet wide, was to be made. The harrowing and dragging process employed by the towboat association proved successful, and a depth of channel of 18 feet was maintained for a whole year.

It is important to remark that this Board recommended that in case that the "stirring-up" process failed, jetties be constructed, remarking that the "project of jetties is based upon the simple fact that by confining the waters which now escape uselessly in lateral directions to a narrow channel, the depth of this narrow channel must be increased. In other words, the existing bar must be cut away."

As a consequence of no further appropriations being made until 1856, the 18-foot channel disappeared. The sum of $330,000 was appropriated in the year mentioned for the improvement of the passes. A Board of Engineers recommended that the bid of the towboat association be accepted for keeping open Southwest Pass by stirring up the bottom, and that the method of keeping open a pass by jetties and closure of lateral passes be applied to Pass a Loutre. The Secretary of War decided that the jetty system be applied to both passes, and a contract was accordingly made with Messrs. Craig & Rightor to do this work. The contractors began at the Southwest Pass by building on the east side a jetty about a mile long, "composed of a single row of pile planks, strengthened at intervals by piles." The structure was entirely too frail, and was so seriously damaged by storms that the plan was abandoned, and the contractors were permitted to resort to the stirring-up process, by which an 18-foot channel was secured and maintained as long as the operation was continued.

In 1867 an appropriation of $75,000 was made and a contract entered into for "stirring up," which was not, however, executed. In the years 1867-1870 the Government built a powerful dredge boat of special design, which was operated under the very best of conditions, but since it simply functioned by stirring up the material with a powerful propeller, and deflecting the disturbed material up into the current with a deflector, it did not succeed in maintaining a much deeper channel than that formerly secured by other means.

The necessities of commerce made it imperative that a better channel connection with the Mississippi River be obtained at an early date. Everybody was tired of the uncertain results secured by dredging on the bars, and as other methods of securing these objects had been advocated, a resolution of the House of Representatives was passed March 14, 1871, providing: "That the Secretary of War be, and he is hereby, requested to cause an examination and survey, with plans and estimates of cost, to be made by an officer of engineers, for a ship canal to connect the Mississippi River with the Gulf of Mexico, or the navigable waters thereof, of suitable location and dimensions for military, naval, and commercial purposes, and that he report upon the feasibility of the same to the House of Representatives."

The survey and estimates for a canal, near Fort St. Philip, were submitted by Capt. C. W. Howell, Corps of Engineers, to a Board of Engineer Officers, composed of Col. J. G. Barnard, Lieut. Col. John Newton, Maj. Q. A. Gillmore, Maj. G. K. Warren, Maj. William P. Craighill, Maj. G. Weitzel, and Capt. C. W. Howell.

This Board, with the exception of one member, reported that the construction of the canal, with a depth of 27 feet and bottom width of 200 feet, having at the river end a lock with chamber 500 feet long, 60 feet width, and depth over sill 25 feet, was feasible and desirable, and was estimated to cost $10,273,000. The dissenting member, General Barnard, claimed, in a minority report, that the experience gained with the dredges was sufficient to warrant still better results, and that the advantages of an open mouth were sufficient to warrant further experiment in this method at Southwest Pass, but, he reasoned, that the success of the jetty system, as applied at the Saluna mouth of the Danube, presaged even greater success if applied at South Pass, and warranted its consideration.

Gen. A. A. Humphreys, Chief of Engineers, United States Army, criticised General Barnard's preference for jetties, and estimates that the rapid advance of the bar will make the extensions of the jetties costly and their maintenance uncertain; that the earthy matter brought to the crest of the bar was not deposited in deeper water, as was contended, but was laid upon the lighter material which was carried in suspension considerable distances beyond the bar and caused the greater portion of the fill, since it was by far the greater portion of the matter transported by the river; that the result of this was to really shoal the water in advance of the bar in such manner that the bar really advanced into shoaler water, and if the jetties were built the material would be restricted as to the areas on either hand, and the advance would be greatly accelerated in consequence.

General Newton, in a review of General Barnard's dissenting report relative to the application of jetties for the improvement of the entrance to the Mississippi River, practically reiterates General Humphrey's views and questions the permanency of the improvement, for the reason that the prolongation of the jetties to keep pace with the rapid increase in the bar would introduce so much resistance to the flow of water, in time, that the water would seek some other pass; furthermore, the prolongation of the main stream must be considered, since it is not known whether the delta advances simultaneously with the prolongation of the main stream, or whether the main stream did not prolong its course violently by breaking through at some point, and so discarding the passes which have for some time been advancing into the Gulf at the average rate of 262 feet per annum.

One of the most remarkable differences of opinion in these discussions is that which relates to the annual advance of the bar formation. General Barnard claimed that if the jetties were extended to the required depth of channel beyond the crest of the bar, and the channel deepened by dredging, the force of the current would be sufficient to project the material so far into the Gulf that the bar would not reach the height of the bottom of the proposed channel until the conditions as to fill and distribution of material in the Gulf approximated that which existed previous to the improvement. General Newton estimated that the bar advance at Southwest Pass would be as much as 1,014 feet per annum, and at South Pass 2,240 feet, the more rapid advance for the smaller pass being due to the greater contraction of the channel between the jetty heads.

The report of the Board upon the canal project was followed by the proposition of Mr. Eads, in

February, 1874, to improve the entrance to the Mississippi River by jetties at Southwest Pass for the sum of $10,000,000, payments to begin when a depth of 20 feet was secured, and continuing as certain greater depths were secured until 28 feet had been secured and $5,000,000 had been paid. The remaining $5,000,000 to be paid in installments of $500,000 each, conditional upon the permanence of the channel for ten years.

A fierce controversy resulted as a consequence of this proposition between the advocates of the canal on one side and the supporters of the jetty scheme on the other, and since the principal part of the discussion was theoretical, it was impossible to decide which was the better until further investigations of the jetty methods could be had. Accordingly, in June, 1874, an act was passed constituting a Commission to investigate and report upon the improvement of the mouth of the Mississippi River. This Commission was organized pursuant to the following order:

General Orders,
No. 74.

War Department, Adjutant-
General's Office,
Washington, July, 2, 1874.

Lieut. Col. H. G. Wright, Lieut. Col. B. S. Alexander, and Maj. C. B. Comstock, Corps of Engineers, United States Army; Prof. Henry Mitchell, United States Coast Survey; T. E. Sickels, W. Milnor Roberts, and H. D. Whitcomb, are, by the President, hereby appointed a Board of Engineers under the provisions of section 3 of the act approved June 23, 1874, entitled "An act making appropriations for the repair, preservation, and completion of certain public works on rivers and harbors, and for other purposes," for the purpose of making "a survey of the mouth of the Mississippi River, with a view to determine the best method of obtaining and maintaining a depth of water sufficient for the purposes of commerce, either by a canal from said river to the waters of the Gulf or by deepening one or more of the natural outlets of said river." They are hereby directed to assemble at New York City, N. Y., on the 20th instant, or as soon thereafter as practicable, for the purpose of organizing and entering upon the performance of their duties. Lieutenant-Colonel Wright is designated as president of the Board. H. D. Whitcomb is designated to disburse, under the direction of the Board, the money appropriated to defray the cost of the survey.

The following is the section of the act of Congress above referred to:

"Sec. 3. That a Board of Engineers, to be composed of three from the Army, one from the Coast Survey, and three from civil life, be appointed by the President; which said board shall make a survey of the mouth of the Mississippi River, with a view to determine the best method of obtaining and maintaining a depth of water sufficient for the purposes of commerce, either by a canal from said river to the waters of the Gulf, or by deepening one or more of the natural outlets of said river; and said board shall make a full and detailed estimate and statement of the cost of each of said plans, and shall report the same, together with their opinion thereon, showing which of all said plans they deem preferable, giving their reasons therefor, to the Secretary of War, to be presented at the commencement of the second session of the Forty-third Congress; and that the sum of $25,000, or so much thereof as may be necessary, is hereby appropriated, out of any funds in the Treasury not otherwise appropriated, to defray the cost of said survey."

Approved, June 23, 1874.
By order of the Secretary of War:

THOMAS M. VINCENT,
Assistant Adjutant-General.

In the report of this Board, submitted January 13, 1875, it is stated: "As there has been no example in this country of the improvement of a large river mouth so as to give an outlet to the sea, with much deeper water than naturally exists on its bar, the Board, in its consideration of what experience has shown elsewhere to be practicable in such a case, has found its only examples in the mouths of European rivers.

"There has been great difference of opinion among engineers, not only in this country, but in Europe, as to whether the best method of securing a deep-water outlet from a sediment-bearing river which empties, like the Mississippi, the Vistula, the Danube, and the Rhone, into a nearly tideless sea, is by jetties or by a lateral canal."

In order to gain a better knowledge of the various rivers abroad which have been improved, the Board visited the rivers named, and also the North Sea and Suez Canal.

The result of these examinations abroad (while additional information has been gained on almost every point relating to the problem before them) has been to largely strengthen their estimate of the value for jetties at the mouth of the Mississippi River of the fascine dikes used in Holland by Calend in the improvement of the Mass mouth of the Rhine.

The Board visited the locality of the proposed canal below New Orleans, and fully considered its plans, etc. It estimated the cost to be $10,296,500 for construction, and $60,885 per year for cost of maintenance.

In considering the method of deepening the water on one of the bars by jetties, the Board makes the following statements:

"On examining a map of the mouths of this river it will be seen that each pass, through the greater part of its length, has a nearly constant width, but that it widens toward its bar, so that on its outer crest it has several times its ordinary width, while its depth is less in something like the same proportion. The cause of this change seems to be the following: The river water as it approaches the bar is somewhat above the level of the Gulf, and so tends to diverge, the stream thus becoming thinner and wider. This thinning and widening is aided by the greater density of the salt water, which makes the fresh water rise over it on a slope that is steeper as the velocity of the river water is less. This thinned sheet of water forms its own banks as the bar moves out to sea; but, as in this wide, shallow stream the friction is great near the banks, deposits begin there, the stream is narrowed and deepened, and in time that part of the stream obtains the form already assumed by the portion above, which allows the water to pass with less resistance. To-day, while there are but 7 feet of water on the outer crest of the South Pass bar, it is yet only about 12,000 feet from the bar to 30 feet of water above the bar, and it follows, if the bar's progress into the Gulf has been for the last one hundred and twenty years the same as for the last thirty-six years (about 100 feet per annum), that one hundred and twenty years ago the outer crest of the South Pass bar was where now there is a deep channel. As the bars move out to sea, the river is, then, all the time eroding a channel of the characteristic deep-water cross section behind and through them. The object of the jetties is to aid and hasten this erosion. If, starting from a point in a pass above this bar, where there are now 30 feet of water, we build jetties which so confine the pass that it shall have the width all the way to deep water it now has at the starting point, we shall be helping the pass to assume the deep-water cross-section it would ultimately take, and by aiding it, if necessary, by dredging, should be able to reduce at pleasure the time required for the process.

"This plan is then adopted for the improvement of a natural outlet, namely, to begin parallel dikes at the banks of a pass where there are now 30 feet of water in the middle and carry them over the bar to 30 feet water outside (unless the depth is obtained before the dikes have reached the 30-foot curve), allowing the river to erode the bottom between the dikes till the waterway between them everywhere has the same cross section as at their beginning, aiding the erosion by dredging or stirring if it is not rapid enough without.

"The Board considered the question of limiting the waterway to the cross section of 30 feet maximum depth by converging jetties on the bar, and by spur dikes in the Pass above, instead of by parallel dikes. In view of the lack of experience in such work in this country, and of the danger of excessive scour around the ends of spur dikes, it was deemed advisable to adopt parallel dikes as offering fewer contingencies and less difficulty of construction. The depth of 30 feet has been chosen in order that some time may elapse before the bar, which will form at the sea end of the jetties, can have less than 25 feet at mean low water upon it, that being the minimum depth which it is desired to maintain.

"Having adopted a general plan for the improvement of one of the natural outlets, it remains to fix on that one. As the improvement of any will be costly, but one should be improved, and that should be made adequate for all purposes.

"The passes which have been most carefully considered are the South and Southwest.

"In comparing these passes, it is seen that while the average width of the body of the South Pass is 700 feet, that of Southwest Pass is about 1,400. The greater width is more favorable to navigation; but, in the opinion of the board, the South Pass, when improved, will be adequate to the present and prospective wants of commerce. The estimated sum required for the construction and maintenance of the works for the improvement of the South Pass is $7,942,110, and for Southwest Pass is $16,053,124. It is assumed that the Southwest Pass bar advances about three times as fast as the South Pass bar.

"The South Pass being entirely adequate, the much greater cost of improving the larger pass would not, in the opinion of the Board, be warranted either by the somewhat greater ease of entering it in storms or of navigating it when once inside. The former is 12.9 miles long, the latter being 18 miles, and is lengthened only about one-third as fast as the latter.

"The cost of improving Pass a Loutre would also be far greater than for South Pass, without advantages sufficient to justify the increased cost. The South Pass has the advantage that the works for its improvement, which would require at least two or three years for their execution, would in no way interfere with commerce. The Board is, therefore, of opinion that if any natural outlet is improved it should be the South Pass.

"The South Pass of the Mississippi is 12.9 miles long, has an average width of 730 feet and a minimum interior channel depth of 29 feet. It is 11,900 feet from the 30-foot curve inside the pass across the bar to 30 feet outside. The minimum depth on the bar is 7 feet. It discharges at its mouth about 57,000 cubic feet of water per second and about 22,000,000 cubic yards of sediment in suspension per annum. It has a shoal at its head, with a minimum depth on it in channel of 17 feet.

"For the improvement of the South Pass the Board recommends parallel dikes or jetties constructed of brush, fascines, and stone, in the same general way as those used by Mr. Calend at the mouth of the Maas.

"These dikes should begin at the two banks of the pass, about 1,650 feet below the South Pass light-house, where the river has a width of nearly 900 feet and a maximum depth of 30 feet. They should run in straight lines parallel to each other in the direction of the pass to where the water is 30 feet deep outside of the bar, provided it should be necessary to carry them so far as to secure 30 feet depth. The dikes for the first 7,100 feet should be 10 feet wide on top; should then widen gradually to 20 feet in a further distance of 2,050 feet; should then gradually widen to 50 feet, which is to be the width in 30 feet of water. At present this last length would be about 2,750 feet and the total length of each dike 11,900 feet. The first 7,100 feet of the dikes to have side slopes of two-thirds (two vertical to three horizontal), the rest to have side slopes of one-fourth down to 15 feet below water, and beneath that depth slopes of one-half; the top of the dikes to be rounded and paved, the crown rising to high water of spring tides.

"The question of the average annual expense of prolonging the jetties is a very serious one. It depends on the annual advance of the 25-foot curve, that depth being required. At present the muddy water issuing from the South Pass spreads out in somewhat of a fan shape, the handle of the fan being at the mouth of the pass and the ribs several miles in length.

"If the proposed jetties were instantly completed and the new channel scoured out essentially the same amount of sediment would be spread out in fan shape, but, from the greater velocity of the issuing water, the ribs of the fan would be longer while the handle would be narrower. More of the sediment would at first be deposited far out in the Gulf than before.

"But with the present rate of advance the 25-foot curve one hundred and twenty years ago was about 12,000 feet above its present position, and if the volume of water carried by the pass is kept the same, neglecting the slight difference in slope of the Gulf bottom outside the present bar, in about one hundred and twenty years a new end for the pass will probably be formed of the same general shape as the lower 12,000 feet of the present pass. It makes little difference, in the whole time required to accomplish the work, whether the same volume of water flows out at starting over the present shallow bar or from between two dikes which force the water to take a depth of 30 feet. In an average of many years the rate of progress must be about the same as now, namely, 100 feet per annum, the volume of water being kept as at present, and it is on this basis that the average annual cost of extension, namely, $130,000, has been computed.

"It has already been stated that it is proposed to obtain a depth of 30 feet between the jetties, in order that some years may elapse before the shoal which will form beyond the jetties can have on it less than the required depth of 25 feet in the channel through it. There are no precise data for estimating this period. Going seaward from the upper end of the proposed dikes, the slope of the bottom of the South Pass is about 1-440. This slope doubtless depends mainly on the velocity of the water flowing through it and on the lifting of the fresh water by the salt. As the causes remain essentially the same, it would seem natural that the new end of the South Pass to be formed by the sediment passing through the jetties should at least have the same bottom slope. If this assumption were true, the bottom would at last shoal from 30 to 25 feet in a distance of 5 by 440=2,200 feet, and the time required would be about twenty-two years. This time would be shortened by two causes: First, there are about 3,000,000 cubic yards of material to be scoured out between the jetties, thus increasing the general bar accretion by that amount and hastening the advance of the pass. As the scour would be distributed over several years, and as the South Pass carries about 22,000,000 cubic yards of sediment in suspension annually to the Gulf, the effect of this 3,000,000 yards cannot be relatively large; second: at and below the point where it is proposed to begin the jetties the river velocity now diminishes very slowly, as it is confined by a slowly widening channel, while when the jetties are completed and the channel scoured out the water issuing from them will, having at first no banks to confine it, spread out more rapidly, thus, perhaps, losing velocity more rapidly and forming a steeper seaward slope on the bottom than now exists at the upper end of the proposed dikes.

"This steeper slope seaward from the 30 feet of water between the jetties would give a shoal of 25 feet at a distance of less than 2,200 feet, and in a period of less than twenty-two years. The period is uncertain; experience alone can determine the precise time. Different estimates made by this method, and others by different members of the board, vary largely, and ten years have been assumed for the purpose of estimate. In ten years, then, it is assumed that the jetties will have to be lengthened 1,000 feet. As shoals will have formed at the ends of the jetties, it has also been assumed that the extension will be in water averaging 15 feet in depth.

"It has been stated that there is a shoal at the head of South Pass, with but 17 feet of water on it. At present this shoal is scouring out. Should that scouring not give a depth as great as at the shoalest point below in the pass, the construction of a dike to deflect more water into it would become necessary. Should the South Pass increase much beyond its present size, it might become necessary to put an apron on the bottom and sides of the pass, near its head, to stop that increase."

The estimated cost of the jetties at South Pass were, for construction, $5,342,110, and $130,000 per annum for cost of extension, etc. For Southwest Pass a similar estimate was made, as follows: First cost of jetties, $8,253,124; annual cost of extension, $390,000.

The Board felt certain that the required depths could be secured by jetty constructions, and recommended that South Pass be improved in this manner, and concludes that if Congress adopts this system that the whole amount should be appropriated at once or in some way be made available.

Gen. H. G. Wright withheld his signature for the reason that he did not believe the method promised an adequate and permanent channel, which the canal project did, and therefore gave his preference to the latter method.

Soon after the presentation of this report Mr. Eads made a new proposition to Congress to make a channel 30 feet deep at the mouth of Southwest Pass for $8,000,000, and maintain it for twenty years for an annual sum of $150,000, a first payment of $500,000 to be made when a depth of 22 feet was reached, and other amounts as greater depths were reached until 30 feet was reached, when a certain sum was to be held as security for maintenance, one-half to be paid at the end of ten years, the other at the end of the twenty years. The complete statement is not repeated, for the reason that it was not accepted.

Gen. A. A. Humphreys, Chief of Engineers, opposed this measure, for the reasons, mainly, that the improvement would not be permanent, and that the rapid advance of the bar would render its maintenance inordinately expensive.

Mr. Eads's able presentation of his case before the House committee, backed by the favorable report of the Board, sufficed to withdraw all opposition, practically, in the House; but when the matter went to the Senate, the possibility of gaining the same results at South Pass at far less cost influenced the members to advise Mr. Eads that if he would not agree to improve the smaller pass for $5,250,000, with the same guarantee, and agree to maintain the 30-foot depth for twenty years at $100,000 per annum, the work would not be placed in his hands. He consented to this, and the bill covering the conditions of the work, modified as to cost and location, became a law March 3, 1875.

The jetties at South Pass were declared finished in July, 1879, at which time the payment for maintenance began to run, and the maintenance of the required channel has been complied with, with the exception of about five hundred days, to date, when the legal channel did not exist. The deficiencies have been distributed between the pass itself, the jetty channel, and the channel through the bar in the Gulf in advance of the ends of the jetties.

The channel in the pass proper is required to have a navigable depth of 26 feet throughout, from the deep water of the main river to the beginning of the jetty channel.

The jetty channel is required to have a channel 26 feet deep and 200 feet wide, with a central depth of 30 feet without regard to width, this channel to continue to the deep water of the Gulf.

Between the river and the jetty channel the pass has filled considerably in places, the tendency apparently being to assume an uniform cross section and slope. Between the jetties filling has occurred at intervals; but the channel is maintained with reasonable success by dredging. Beyond the jetties a bar has formed, through which a channel is maintained with but little dredging so far. A chart showing the advance of the different curves of depth between 1879 and 1896 beyond the sea ends of the South Pass jetties is attached.

CONCLUSIONS

Upon examining this chart, the manner of the reforming of the bar is disclosed. The greater portion of the sediment ejected by the pass is deposited to the westward. The 20 and 30 foot curves exhibit this in a marked degree in the immediate vicinity of the jetty ends. The 40-foot curve seems to be less affected in the area examined, but probably inclines shorewards on the easterly side upon the prolongation of the line shown. The 50-foot curve of 1896 probably inclines shorewards on the east, like the 40-foot, but all the curves beyond the 40-foot curve of 1896 are very irregular, though possessing identical features. Three distinct valleys are indicated as penetrating the formation in front of the jetty ends; a very pronounced one to the east, a second similar one to the west, and one not quite so pronounced between these. Below the 40-foot curve of 1896 a ridge extends as far as the 100-foot curve, and probably beyond. This ridge is in line with the 30-foot channel between the jetties, and that through the bar to the eastward of the axis. The ridge to the west of this is not so marked, and the middle valley may almost be disregarded as of little consequence compared with the very pronounced valleys to the east and west of it. These deep valleys have their center lines inclined nearly in the direction of the prevailing wind, and are due to wind and tidal currents, which oppose the issuing stream and deflect it to one side or the other. Between these valleys the important advance of the bar has taken place, since this included area is in front of the jetty entrance.

The shoal which has formed directly in front of the entrance is the outgrowth of several conditions: First, the sediment which was deflected by the cross current; second, the finer material which floated beyond the influence of the river current, and was returned by the action of the wind and waves. This shoal is having more and more influence upon the issuing current, and tends to deflect it more and more into the face of the prevailing winds. The ultimate effect will be to cause the direct interference of the cross current and issuing currents, and a consequently more rapid deposition of the material to the eastward of the line of issue. The speedy restoration of normal conditions will then result, for the influence of the jetties will no longer prevail, the extension of the bar will resemble that before the improvement was undertaken. The material to the eastward of the jetties will be far less than that to the westward, however, and when the extension of the jetties to meet the new conditions becomes necessary, the east jetty will not have the width of foundation to insure its permanence for any considerable length of time.

The issue of the water from the opening between the jetty ends shows that the force of the current is sufficient under present conditions to not only carry the sediment some distance in advance of the jetties, but to excavate a basin of considerably greater depth than that in the channel between the jetties. The force of flow is therefore sufficient to drive the salt water from in front of the entrance and hold it in abeyance for the greater part of the time that the issuing current is charged with a material amount of sediment, and during low river, when there is no sediment in suspension, the ebb tide is sufficiently strong to maintain this small basin and the channel through the bar, the shoaling effect of the tidal current being greater between the jetties than outside.

Unless the sediment borne to the mouth of the jetties could be entirely eliminated, it is folly to imagine that such a system of improvement can give permanent results, and although the prolongation of the jetties may not be required, and, indeed, be impossible for some time, there surely comes a time when prolongation must take place, and this extension will be both expensive and difficult.

The prolongation will have to be made on the narrow ridge directly in front of the jetties, where the shoaling is greatest and the duration of the beneficial results the least, or a lateral course must be pursued with far less promises of durability. The system itself is incapable of being made to endure for all time, but must, in the natural order of things, come to a positive end and be abandoned.

The principles of bar formation are practically as stated by Humphreys and Abbot, so long as the natural conditions exist. The bar advance is explained and the theory is sufficiently exact to meet the situation, but when the natural conditions are disturbed by the construction of confining jetties the advance of the bar is not made in exactly the same manner, since the issuing water has sufficient force to carry the material some distance into the sea, where the deposit takes place in deep water and where the re-formation of the natural bars commence and grow, until the conditions in advance have been restored, and the lateral areas built up so as to form natural banks or shoals, and so bring about a restoration of natural conditions.

The natural rate of advance of the bar gives an approximation of the time which may be estimated to elapse from the time when the jetties are completed to the time when the bar will have re-formed, or to the time when the further extension of the jetties will be necessary, supposing the conditions at the Head of the Passes to continue favorable.

At South Pass the depth of channel required is 30 feet at flood tide. The 30-foot curve has advanced between 1879 and 1896 a distance of about 700 feet. Measured on a line from the most advanced point of the curve of 1879, and parallel with the present 30-foot channel through the bar to the westward of this, the advance has been much greater. On the prolongation of this line, where the advance of the 40-foot curve has been the least, the advance of the 40-foot curve has been 900 feet, and practically occupies the position of the earlier 50-foot curve. Beyond the 40-foot curve the advance of the other curves have been far greater, the 60-foot curve of 1896 coinciding with the 80-foot curve of 1879.

The distance between the 30-foot curve outside the natural mouth and 40-foot curve before the jetties were built was 1,600 feet, or a slope between of 1-160, and between the 40-foot and 50-foot curves the slope was 1-20. At present the slope between the 30 and 40 foot curves is 1-90, or much steeper, and between the 40-foot and 50-foot, measured on the same line to the nearest point of 50-foot curve, about the same slope (1-90), much flatter.

Before improvement, the distance from the inside 30-foot curve of depth to the 20-foot curve of depth was about 2,900 feet. The end of the 30-foot channel was well inside of the protection of the natural banks; but measuring off the 2,900 feet from the ends of the jetties, in the direction heretofore used, the end of this measurement would fall about midway between the most advanced and least advanced positions of the present 40-foot curve of depth in the Gulf, as the filling at this locality has been about 0.6 of a foot a year. If this rate was to continue, the 40-foot depth would have shoaled to 20 feet about the year 1929.

Originally the distance between the 30-foot curve inside and the same curve outside was 12,300 feet. In 1896, from the ends of the jetties to the outside of the 30-foot curve, ignoring the channel through the bar, which has failed, at times, to maintain the 30-foot depth, the distance is only about 1,600 feet.

The plateau which supports the bar, which has less than 30 feet of water over it, is very large, and is approximately without limits on the eastern side. So long as this condition prevails the growth of the bar in height will be retarded, but this condition will be greatly changed when the bank on the west has extended a little farther. It is reasonable to expect that when the 20-foot contour shall have reached the present 50-foot contour's position the bar will have considerably less than 30 feet of water over it, or through it. At the present advance of this 20-foot contour the 50-foot contour will be reached, in all probability, by 1913; at the present time the 30 and 40 foot curves approach each other closely on the west side. On the east side the approach is not so near. The 30-foot about coincides with the 40-foot contour of 1879, while on the west side the 20-foot contour coincides with the 40-foot of 1879 (later survey shows it has nearly reached the 40-foot), or the 20-foot (of 1896) contour advances much more rapidly than the 30-foot on the east. Unless the basin in front of the jetties enlarges much more rapidly than it does, the bar will be so broad that it will be impossible to maintain through it with a reasonable amount of dredging a channel of 30 feet, and it is doubtful if this channel could be maintained uninterruptedly at 25 feet for any length of time.

Under the very best of conditions, the life of the 30-foot channel, created and maintained by jetties and dredging, will not last at South Pass beyond 1913, or say for thirty-four years from completion, although the restoration of the bar to its natural condition would require one hundred years or a greater period.

The situation at Southwest Pass is not so favorable as at South Pass, so far as the transverse current is concerned, the current being comparatively weaker at this place, the advance of the bar appearing to be very symmetrical with the axis of the pass.

The advance of the bar between the time of the survey of this pass by the Coast Survey of 1867 and the present survey is shown on the accompanying chart. This covers a period of thirty-one years, and the annual advance for this whole time is at the rate of 251 feet a year. To maintain this advance, it would require, to fill up the areas in advance and on either hand, the annual deposit of about 32,000,000 cubic yards of material, sufficient, if it were piled on the square upon which the Capitol at Washington stands (a square which is about 1,650 feet by 1,400 feet), to raise the level of the ground several feet above the top of the statue on the top of the Capitol dome.

The rate of advance of the bar has undergone considerable variations at different epochs, as shown in Mr. Ockerson's report. In the interval between 1838 and 1857 the advance was 239 feet per annum. In that between 1857 and 1873 it was 401 feet per annum, and between 1873 and 1898 it shows but 176 feet advance per annum. The interval previously alluded to covers part of the time when the bar had its most rapid advance and is, therefore, considerably greater than the present.

There is a very material falling off in the advance of the bar since the survey of 1873. If the quantity of material transported is proportioned to the volume of water, it would appear that the volume of discharge had materially diminished. In 1873, at flood tide, the discharge was stated to be 408,000 cubic feet per second. Mr. Ockerson's observations give 370,000 cubic feet as the discharge, when the river was at something less than a high-water stage, probably what might be called a mean high-water stage, and for such a stage the discharge is stated to have been, in 1873, 340,000 cubic feet.

The exact data relative to the stage of the river corresponding to the mean high water is not stated. It may be inferred that the discharge of Southwest Pass has not diminished materially since 1873, or sufficiently to account for the decrease in the rate of advance in the bar since then. It is possible that the character of the material brought to the bar has undergone some changes in recent years, and the heavier material which forms the bar proper may have diminished, and the lighter material held in suspension increased. (The rapid advance of the 60 and 70 foot contours of depth at South Pass would indicate some such change.) There may also have been some deflection of the heavier material at the head, owing to the sill sunk across the pass by Mr. Eads. The advance of the bar into the Gulf, since greater depths must be filled in, will account for some of the loss, but there certainly remains a considerable loss of bar-building material that is unaccounted for.

During the times the bar was advancing rapidly, the depth of water on the crest of the bar was the greatest. This would appear to indicate a loss of velocity which, since the discharge at the head of the pass seems to be unchanged, could only occur through the increased discharge of the lateral openings above the mouth.

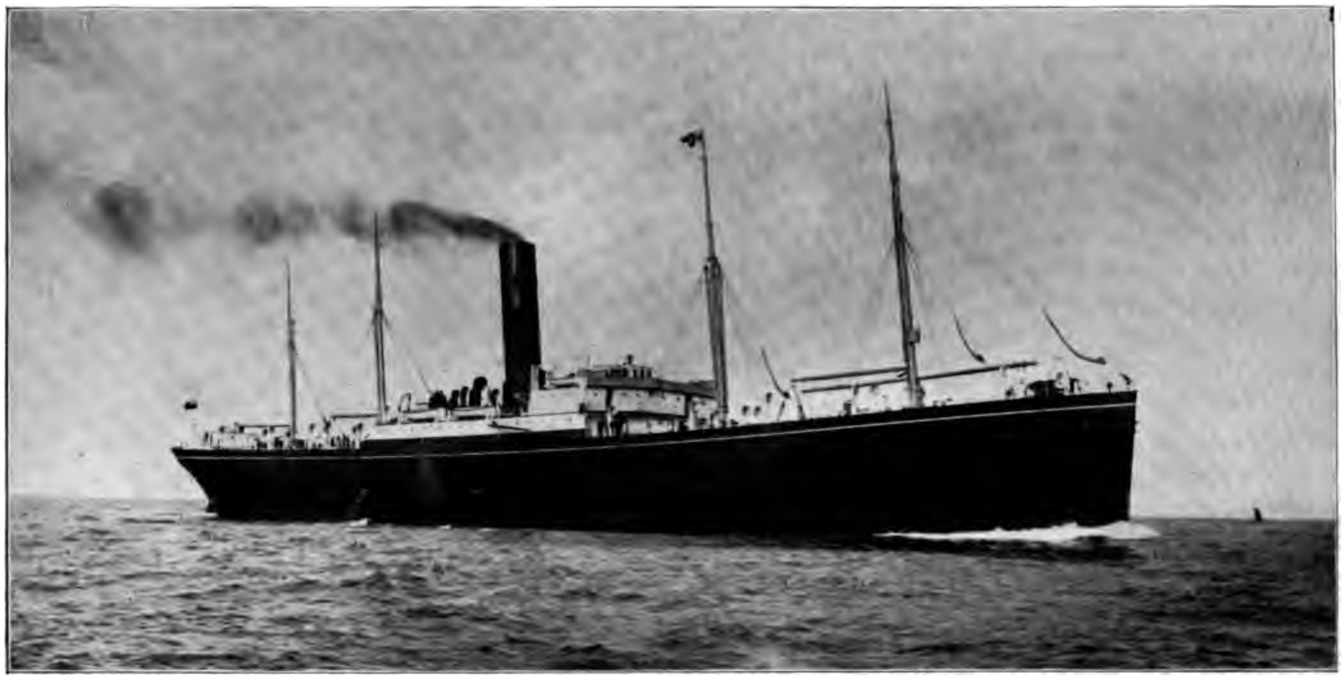
The slope of the pass varies from 2 feet at high water to 0.6 foot at low water. At high water the slope is very steep from the head to about one-fourth the way down, where some irregularities occur. From below this point to the Pilot Station Bayou the slope is more moderate, but is adequate to give sufficient velocity of flow to the water to enable it to maintain a very deep channel. Between the last station inside the banks to Stake

Island the slope is much steeper than the section just above. As this last section is where the expansion of channel occurs, this sharp descent is to be expected. If the slope can be equalized throughout the entire length of the pass, from head to crest of bar, it seems that it would be sufficient to maintain a satisfactory current to deepen the channel across the bar to as much as is desired. To accomplish this the pass will have to be leveed and all lateral openings closed.

The principal object to be gained in constructing the levees and jetties is to secure, if possible, a channel from end to end of the pass, which shall have, as nearly as possible, an uniform capacity for discharge, and be as free as possible from bends throughout.

As the prolongation of the jetties will in time be necessary, the durability of the constructions must be such that no reconstruction will be necessary, but the work must be capable of extension, without unnecessary expense for preparation.

Although the pass is longer and the discharge of sediment greater than at South Pass (it is not deemed profitable to look further for an example), it is believed that the deeper channel can be maintained with a reasonable amount of dredging for at least thirty years, and that the extension of the jetties will not be positively demanded until some time later.



"CLEARED THE PASSES AND SOUTHWARD BOUND."

STUYVESANT FISH.

DEEP WATER AT MOUTH OF THE MISSISSIPPI RIVER

Statement to the Committee on Rivers and Harbors of the U. S. House of Representatives

BY STUYVESANT FISH

PRESIDENT OF THE ILLINOIS CENTRAL RAILROAD COMPANY, MARCH 6th, 1900

Mr. Chairman and Gentlemen of the Committee:

May I be permitted to invite your attention to the channels through which the foreign commerce of the United States flowed in the period immediately preceding the Civil War, before natural conditions had been disturbed by civil strife, by subsequent misgovernment in the Southern States, and by the welding together of what are now known as the great East and West Trunk Line Railways? With these facts before us, we will then contrast present conditions, and leave to you and to Congress the task of so legislating as to restore the natural conditions of fair and free competition between the several ports of our common and united country.

Without claiming that the specific provision of the Constitution (Art. I, Sec. 9), forbidding the giving of preferences to the ports of one State over those of another, requires this to be done, I do claim that the spirit of that instrument, and common sense and common justice alike, demand that the mouth of the Mississippi river be NOW made and kept navigable by any ships which do, or may, enter any of the ports of the United States.

EXPORTS UNDER NATURAL CONDITIONS.

In two of the three years immediately preceding the Civil War the domestic exports through New Orleans exceeded those through New York in value.

In the five years ended June 30, 1860, the domestic exports through New Orleans increased not only in a greater ratio, but to a greater extent than did those through New York.

In those five years New Orleans had 28.38 per cent of the export trade of the United States; New York, 30.95 per cent; Boston, 5.60; Philadelphia, 1.83; Baltimore, 3.15; San Francisco, 3.27. All other ports, 26.82 per cent.

The value of the exports through New Orleans was not swelled by abnormal prices of cotton, which ranged, in 1858, from 8¼ to 12⅜ cents, in 1859 from 10⅜ to 12⅜, in 1860 from 9¼ to 12. The present price of the same article, middling cotton, at the same place, New Orleans, is 9¼ cents per pound.

IMPORTS UNDER NATURAL CONDITIONS.

In each of the five years, 1856 to 1860, inclusive, New Orleans imported a greater value of foreign merchandise than either Philadelphia, Baltimore or San Francisco.

Throughout those five years New Orleans imported 6.17 per cent in value of the foreign goods brought into the United States, against 5.69 imported through Baltimore and San Francisco taken together, and 4.61 per cent through Philadelphia, while New York then had 62.71 per cent, and all the other ports 20.82 per cent thereof.

CONTRAST.

Let us now look into the flow of our national commerce under the artificial conditions since created, and particularly into the figures for the past five years.

The reports of the United States Bureau of Commerce and Navigation show that, during the year ended June 30, 1862, there were neither exports nor imports through New Orleans, and that, in the four years from July 1, 1861, to June 30, 1865, her total foreign commerce, including both exports and imports, amounted to only $17,831,005. This as against a like commerce in the single year 1860 of $130,735,353. The ravages of the Civil War so effectually crippled the trade of New Orleans that, in the succeeding years of internal peace and prosperity, those figures of 1860 were never exceeded until 1892, and have not since been equaled.

I have in vain tried to get figures for the year ended June 30, 1899, and must be content with those for 1898.

The following table contrasts the conditions prevailing for five years before the Civil War with those of the past five years. It shows that, notwithstanding the enormous growth of the Middle West in the intervening thirty-eight years, New Orleans alone, of all the ports in the United States, has lost in the value of her exports, and that her share of the foreign imports has dwindled down to less than one-fiftieth (1.85 per cent) of the value of those of the United States.

COMPARATIVE STATEMENT OF FOREIGN COMMERCE

For the five years 1856 to 1860, inclusive, under natural conditions, and for the four years 1894 to 1898, inclusive, under changed conditions.

DOMESTIC EXPORTS.

PORTS.	5 YEARS ENDED JUNE 30, 1860		5 YEARS ENDED JUNE 30, 1898		CHANGES IN PER CENT OF TOTAL	
	Average yearly value	Per cent of Total	Average yearly value	Per cent of total	Increase in per cents	Decrease in per cents
New York	$102,257,675	30.95	$459.811 892	43.52	12.57	
Boston	18,613,657	5.60	96,051,735	9.09	3.49	
Philadelphia	6,059,011	1.83	43,581,218	4.13	2.30	
Baltimore	10,403,907	3.15	82,223,787	7.78	4.63	
New Orleans	93,817,338	28.38	88,432,371	8.37	.....	20.01
San Francisco	10,808,085	3.27	39,051,660	3.70	.43	
All other ports	88,622,993	26.82	247,270,731	23.41	.....	3.41
Total, U. S	$330,482,666	100.	$1,056,428,394	100.		

FOREIGN IMPORTS.

New York	$208,080,149	62.71	$516,265,696	64.21	1.50	
Boston	41.395,022	12.50	68,594,782	8.54	.....	3.96
Philadelphia	15,294,205	4.61	45,324,561	5.64	1.03	
Baltimore	9,625,993	2.00	11,607,868	1.46	.....	1.45
New Orleans	20,486,416	6.17	14,832,375	1.85	.....	4.32
San Francisco	9.227,692	2.79	49,329,545	6.14	3.36	
All other ports	27,606,116	8.32	97,839,303	12.17	3.85	
Total, U. S	$331,815,533	100.	$803,794.130	100.		

The figures as to exports and imports, referred to above, are more fully set forth in the tables "A" and "B," submitted herewith in manuscript, but not printed.

The population of the United States was:

In 1860............ 31,443,321
In 1890............ 62,622,250

Increase .... 31,178,929 or 99.16 per cent

The population of the States bordering immediately on the east bank of the Mississippi river (Wisconsin, Illinois, Kentucky, Tennessee, Mississippi and Louisiana), and the States and Territories west thereof, was:

In 1860.......... 10,081,097
In 1890........... 26,891,249

Increase .... 16,810,152 or 166.75 per cent

The population of the States east of those bordering immediately on the east bank of the Mississippi river (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Delaware, Virginia, including West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Ohio, Indiana and Michigan) was:

In 1860............ 21,362,224
In 1890............ 35,731,001

Increase .... 14,368,777 or 67.26 per cent

Or, to put it in another way, of the 31,178,929 increase in the United States, 16,810,152, more than one-half (53.92 per cent) has taken place on, and west of, the Mississippi, and 14,368,777, or 46.08 per cent thereof, has taken place east of the States bordering on that river.

The wealth of the United States was:

In 1860.......$16,159,616,068
In 1890....... 65,037,091,197

Increase ....$48,877,475,129 or 302.47 per cent

That in the States on, and west of, the Mississippi river, was:

In 1860.......$ 5,209,502,149
In 1890....... 29,704,269,881

Increase ....$24,494,767,732 or 470.19 per cent

That in the States east of those bordering on the east bank of the river, was:

In 1860.......$10,950,113,919
In 1890....... 35,332,821,316

Increase ....$24,382,707,397 or 222.67 per cent

The Census of 1900 will doubtless show still greater gains in the West.

Obviously, the loss to the Nation of foreign commerce through New Orleans was not due to a diminution in the population or in the wealth of the territory naturally tributary to that port.

That the domestic exports through New Orleans in recent years have been large, and are rapidly growing, is due to three causes:

I.—The geographical position of New Orleans.

II.—The exceptional facilities afforded by the railroads radiating thence in various directions for reaching all parts of the interior.

III.—The relative cheapness of real estate in New Orleans as compared with the cities on the Atlantic Seaboard.

I.

The short rail distances from some of the interior grain markets and packing house centres to New York and to New Orleans, are:

	To New York. Miles.	To New Oreeans Miles.	Saving to New Orleans. Miles.
Chicago, Ill	912	912	0
Duluth, Minn	1,390	1,337	53
Minneapolis, Minn	1,332	1,279	53
St. Paul, Minn	1,321	1,268	53
Sioux City, Ia	1,422	1,258	164
Omaha, Neb	1,402	1,070	332
Dubuque, Ia	1.079	988	91
St. Louis, Mo	1,058	695	363
Peoria, Ill	1,006	860	146
Cairo, Ill	1,089	554	535
Evansville, Ind	989	708	281
Louisville, Ky	867	746	121
Nashville, Tenn	939	557	382
Denver, Col	1,932	1,356	576
Kansas City, Mo	1,335	878	457

From data compiled in connection with the Census of 1890 we can determine where the following important centres in the United States, exclusive of Alàska, then were:

The centre of area is in Smith county, in northern Kansas, some 200 miles west of the Missouri river, in west longitude 98° 50′.

The centre of wheat production then was in the western part of Hancock county, Illinois, in longitude 91° 29′, and not far from Keokuk, in Iowa.

The centre of corn production then was in Lewis county, Missouri, in longitude 91° 37′.

The centre of population then was in the southern part of Decatur county, Indiana, in longitude 85° 33′.

The centre of manufactures then was some miles south of President McKinley's home, Canton, Ohio, in longitude 81° 34′.

Except the centre of area, on which our recent acquisitions may or may not be considered as having any effect, each of the other centres may be broadly said to be moving westward at the rate of about 50 miles in ten years.

A glance at the map will show that every one of these centres is within the area drained by the Mississippi river, excepting possibly the centre of manufactures. But this point, although very close to the northern rim of the watershed, lies 150 miles west of the main ridge of the Alleghany Mountains.

Each of these centres lies close to the 40th degree of north latitude.

New Orleans is in longitude 89° 58′ and in latitude 30° 1′.

Is it not natural that the products of the valley should go 10 degrees down hill to the gulf, instead of going 15 degrees over the mountains to the Atlantic?

You, gentlemen in Congress, are legislating for the whole country and for the future, and must not neglect the constant movement westward.

The figures given above are those taken for the Census of 1890, touching the crops raised eleven years ago in 1889, and relate to wheat and corn alone. A valued friend of mine in one of the departments here in Washington, to whom I am indebted for much of the foregoing, writes me:

"I have also had a rough calculation made concerning the entire cereal production. Assuming the equality of a bushel of each cereal, and considering Louisiana and Minnesota as located entirely west of the Mississippi river, I find that the production of cereals west of the Mississippi in 1889 was 1,815,635,871 bushels, and that east of the Mississippi was 1,703,181,033 bushels. In other words, the production west of the Mississippi exceeded half of the total product of the United States by about fifty-six and one-half million bushels. This does not prove that the centre of cereal production lies west of the Mississippi river, though it seems to raise a presumption on that side."

II.

As to the exceptional facilities afforded to New Orleans by her railroads, permit me to quote from what I said last October to the Industrial Commission:

"Terminating in New Orleans and radiating therefrom into the interior in all directions are six great railroads:

1. The Southern Pacific, operating. 7,614 miles and extending through Louisiana, Texas, New Mexico, Arizona and California to Portland, Oregon, as well as through Nevada and Utah to Ogden, with branches reaching into the Indian Territory and the Republic of Mexico.
2. The so-called Queen & Crescent Route, operating.......... 1,155 miles in Louisiana, Mississippi, Alabama, Tennessee and Kentucky, and reaching Cincinnati, O.

3.	The Louisville & Nashville R. R., operating, in its own name...... 2,988 miles, and controlling, through an ownership of stock, the Nashville, Chattanooga & St. Louis R. R., which operates.. 1,189 miles.	
	Making together.......	4,177 miles
	The lines of these two companies lie in Louisiana, Mississippi, Alabama, Florida, Tennessee, Georgia, Kentucky, Illinois, and reach St. Louis on the West, Cincinnati on the Northwest, as well as all the lower crossings of the Ohio River, except Cairo.	
4.	The Texas & Pacific Railway, operating in Louisiana and Texas	1,492 miles
	While this railway is affiliated with the so-called Gould System of Railroads which comprise in all 9,000 miles, reaching through Arkansas, Indian Territory, Missouri, Kansas, Colorado, and Nebraska to Denver, Omaha, Kansas City and St. Louis, only the mileage actually controlled by the corporation operating in New Orleans, the Texas & Pacific Railway Company, is considered in this connection.	
5.	The Yazoo & Mississippi Valley R. R., operating in Louisiana, Mississippi, Arkansas and Tennessee	1,001 miles
6.	The Illinois Central R. R., operating in Louisiana, Mississippi, Alabama, Tennessee, Kentucky, Illinois, Indiana, Wisconsin, Iowa, Minnesota and South Dakota.............	3,995 miles
	Railroad mileage tributary to New Orleans........	19,434 miles

No other port in the United States is served by railroads reaching, under single managements, so far and in such varied directions into the interior of the continent."

The mileage here given has been brought down to date, and exceeds that stated in October by 348 miles.

III.

It is universally admitted that, in these days of low freights by rail, the terminal expenses are an important, if not a controlling, factor in the competition of rival ports. The assessed value of all the real estate in New York (Greater New York) is $2,932,445,464, the area of the city is 307.34 square miles, the assessment per acre $14,908.

The assessed value of all the real estate in New Orleans is $103,000,000, the area of the city is 228 square miles, the assessment per acre $706.

That is to say, the average of the assessed value per acre of all the land in New York is more than twenty-one times as great as in New Orleans.

It is within my knowledge that assessments in New Orleans generally approach to, and often exceed, the actual selling value, and that, in New York, they are generally about 60 per cent thereof, and often less.

The transfer to ships of freights, especially the bulkier articles of export, grain, cotton, lumber and the like, require the use of large and ever-increasing areas of land in close proximity to navigable water. Where land is cheapest there will freight be most cheaply transferred to ships.

The assessed value of all the real estate per acre in San Francisco and in Philadelphia is fifteen times greater than in New Orleans, in Baltimore it is eighteen times and in Boston more than forty-four times. In this cheapness of land lies one of the advantages of the Southern ports which merits more attention than it has received.

That the partial restoration of natural conditions which has been brought about, in a large measure at least, by the railroads, has attracted the attention of Congress, and of the other ports, is shown by your action in appropriating, last year, $6,500,000 to provide a direct channel to the sea from New York.

The New York Commerce Commission, appointed in pursuance of a law passed by the State of New York in 1898, and subsequently amended in 1899, and the urgest and persistent efforts of the New York Chamber of Commerce, had much to do with your making that wise and timely appropriation for our chief national port.

The report of the New York Commerce Commission quotes as follows from a statement read to the commission by Mr. Gustav H. Schwab, of the North German-Lloyd Steamship Co.:

"As has been the case in railroad transportation on land, the great factor in cheapening ocean transportation has been the increase in the carrying capacity of vessels, accompanied with constant improvements in motive power, that materially reduce the cost of transportation per ton of cargo moved. Where thirty years ago vessels of 2,500 tons gross register were considered the largest that could be economically and safely operated, now freight steamers of 12,000 tons are regularly employed in the transportation of enormous cargoes. This gradual increase in the size of the vessels necessitated by the demand of commerce for cheaper transportation, has called for a greater depth of water in the channels leading into and out of the harbor of New York; and, on the other hand, as the demands of commerce were recognized by the National Government, and as the channels were increased in depth, the number of large freight and passenger carriers grew. In the year 1870, the maximum draft of vessels can be quoted at 22 feet, at a time when the minimum depth in the channels of New York harbor at mean low tide was 23 feet. In 1880, the draft of steamers had increased to more than 23 feet, the depth of water in the channel showing 24 feet in that year. In the year 1890 the efforts of the government had resulted in a depth at mean low water of 30 feet, both in the main ship channel and in the Gedney channel, permitting the construction of the enormous freight carriers of the present day, whose draft frequently reaches 30 feet, and in some cases exceeds that measurement.

A comparison of the range of freight rates during these years illustrates the advantages gained by the improvements made in ocean transportation during the last thirty years, improvements which have been rendered possible by the action of the national authorities in deepening the approaches to the harbor.

In the following table the average rates of freight from New York to one of the continental ports of Europe are quoted as they prevailed in the years 1870, 1880, 1885, 1890, and 1895. These rates are subject to fluctuations, but in the main represent the course of the freight market:

RATES OF FREIGHT.

DURING YEARS	1870.	1880.	1885.	1800.	1895.
Grain, per 100 lbs.	38	30	15	8½	8
Provisions, per 100 lbs.	50	36	22	21	20
Cotton, per 100 lbs.	80	50	37	35	25
Tobacco, per hosshead	10 00	7 80	6 60	6 00	6 00
Tobacco, per case	3 00	2 85	1 68	1 35	1 20
MEASUREMENT.					
Goods, per cubic ft.	24	20	15	12 to 15	10 to 1

These figures, while varying in some years, showing a temporary increase now and later again a reduction, sufficiently indicate the general trend of rates downward as improvements are effected in the vehicles, with free ingress and egress into and from our harbor.

The present size and capacity of ocean steamships now demand a further material increase in the depth of water provided in our channels. Freight carriers drawing thirty-one feet of water are now not infrequent, and with the advent in the near future of greater vessels, and the necessity for protecting the producer in the West by enabling him, through the medium of cheap transportation to the markets of Europe, to compete with South America, Australia, and India, the imperative urgency of an improved channel capable of accommodating vessels of thirty-five feet draft in the near future should be apparent to all who have at heart the best interests not only of our city and State but of the whole country."

Mr. Schwab, in reading the foregoing statement, added:

"It might be proper for me, being a steamship man, to explain that, in my personal opinion, I hold that a depth of forty feet will be required in the very near future. Probably you are aware of the fact that to float a steamer successfully over the bar it is necessary to have three feet of water under her keel. The west winds of the harbor frequently drive the water out so that there is sometimes four feet less. When we speak of thirty-five feet or forty feet, that is mean low water."

The New York Commerce Commission then go on to say:

"As a result of earnest and united endeavors to secure the much-needed improvements in the harbor approaches, the National Congress has made ample provision for the direct channel to the sea, forty feet in depth and two thousand feet wide, and on May 12th, 1899, a contract was entered into for the active prosecution of the work."

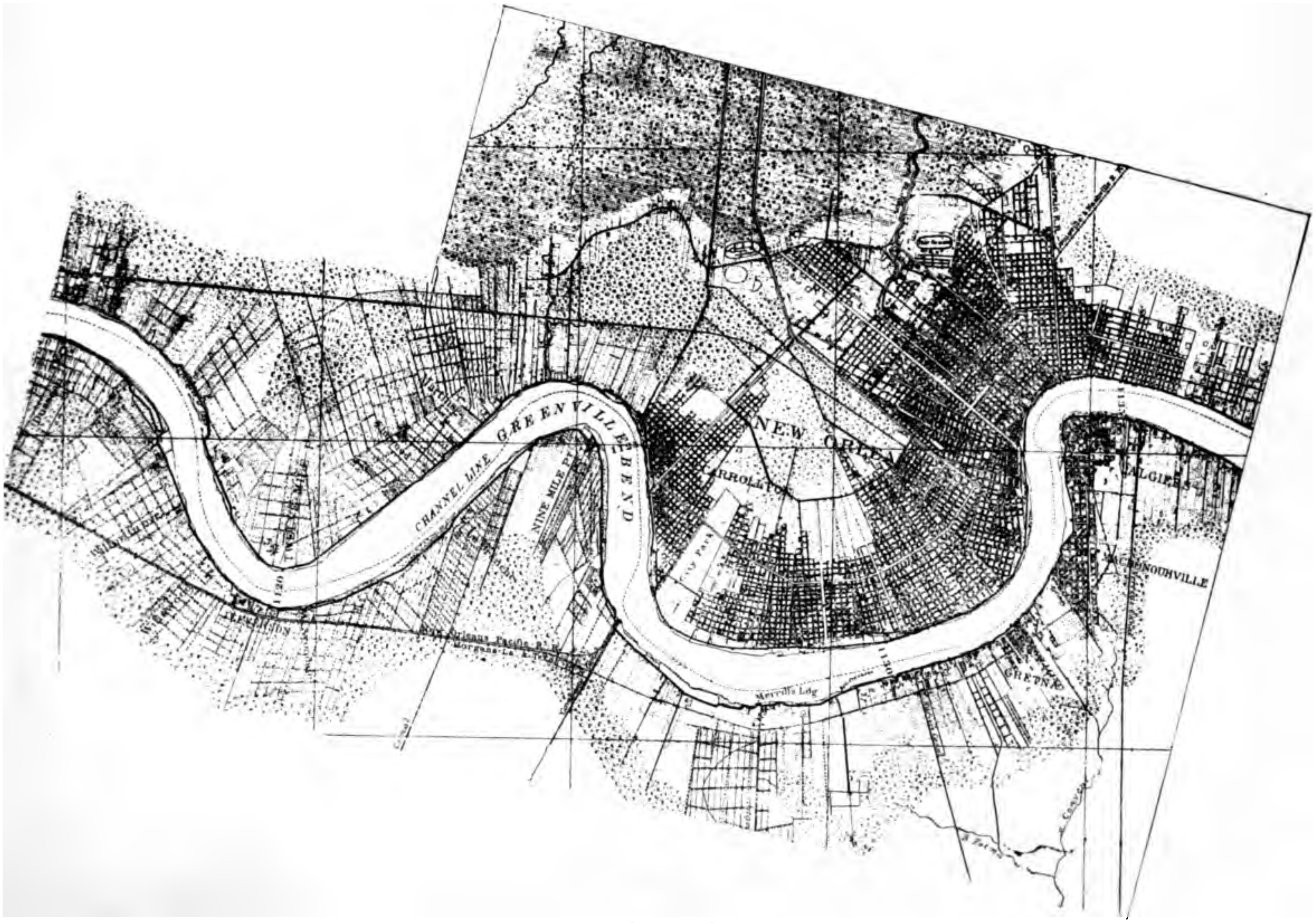
New York having thus, and very properly, been provided with enough for all her needs in the present and in the immediate future, we come before you pleading the cause of the Great Central Basin of the United States, which is drained by the Mississippi river, rather than as saying anything for its seaport, New Orleans.

The Mississippi river drains the whole of nine States and Territories, and parts of twenty-three other States, not to speak of a considerable slice of the Dominion of Canada. Rejecting eight States, of which but a small portion lies within the valley, *twenty-four* States and Territories may be fairly considered as tributary to that river. The valley contains 1,240,039 square miles, or 41 per cent of the area of the United States, exclusive of Alaska and other outlying possessions. There dwell nearly one-half of our citizenship.

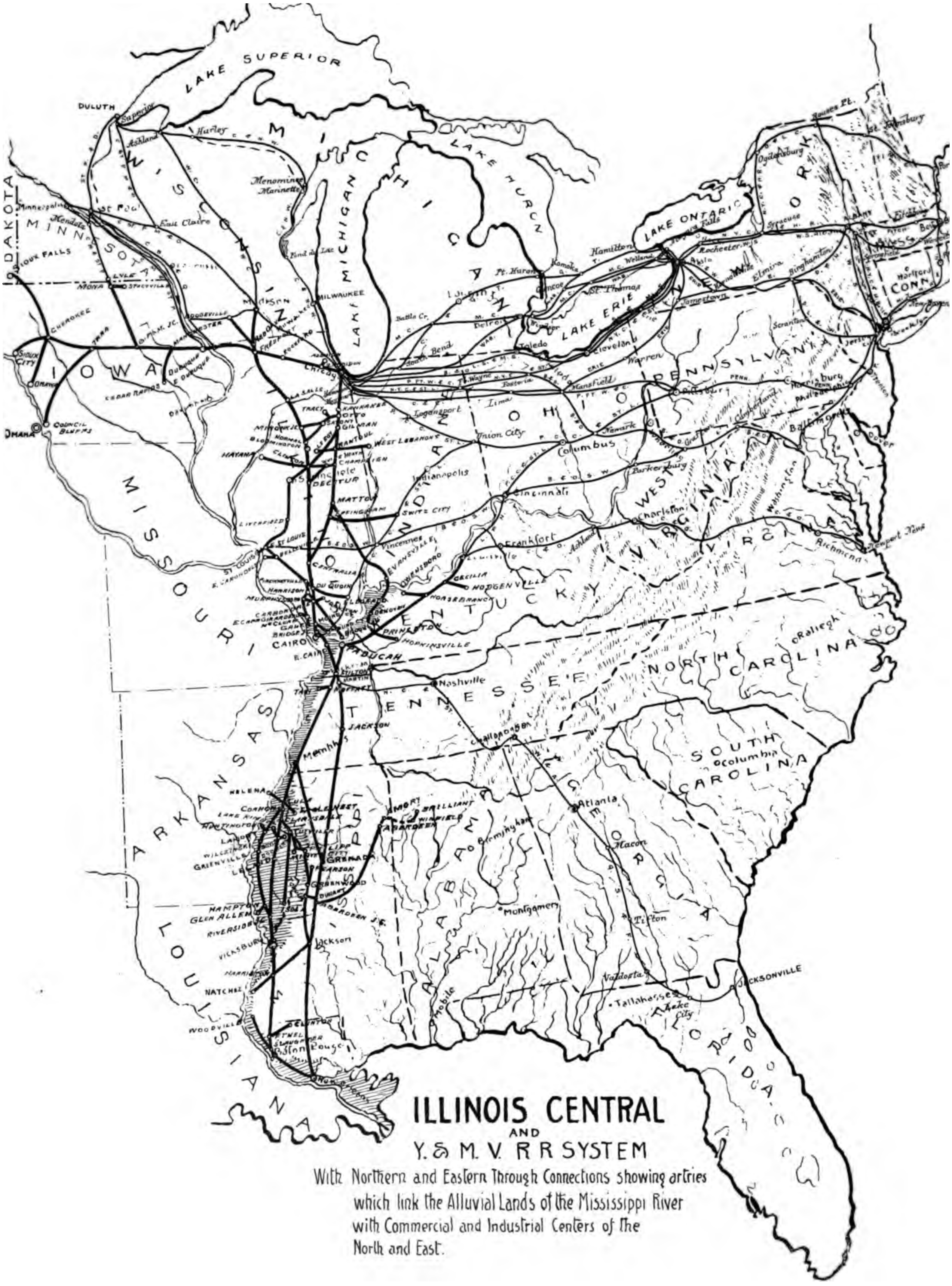
Its soil, beside feeding our own people, except those on the Pacific coast, yields the whole of our exportable surplus of live stock of every kind, and most of the breadstuffs. Its mines yield our petroleum oil and most of our coal, its forests supply our lumber, and its workshops turn out, annually, an increasing share of our manufactures.

Omitting the two Territories, which are, of course, represented by their delegates, those twenty-two States send 44 Senators and 200 Representatives to Congress. In 1896 they cast more than half of the total vote in the Electoral College, 247 out of 447. The 149 votes of ten States went to Mr. McKinley, and the 98 votes of the other twelve to Mr. Bryan. As between the two great political parties, the basin drained by the Mississippi is fairly debatable ground.

The question which we present to you to-day is whether the citizens of the great central basin of these United States are, or are not, to be now given the means of getting their products carried to sea, at the least possible cost to them, in ships which can compete with those sailing from other ports?

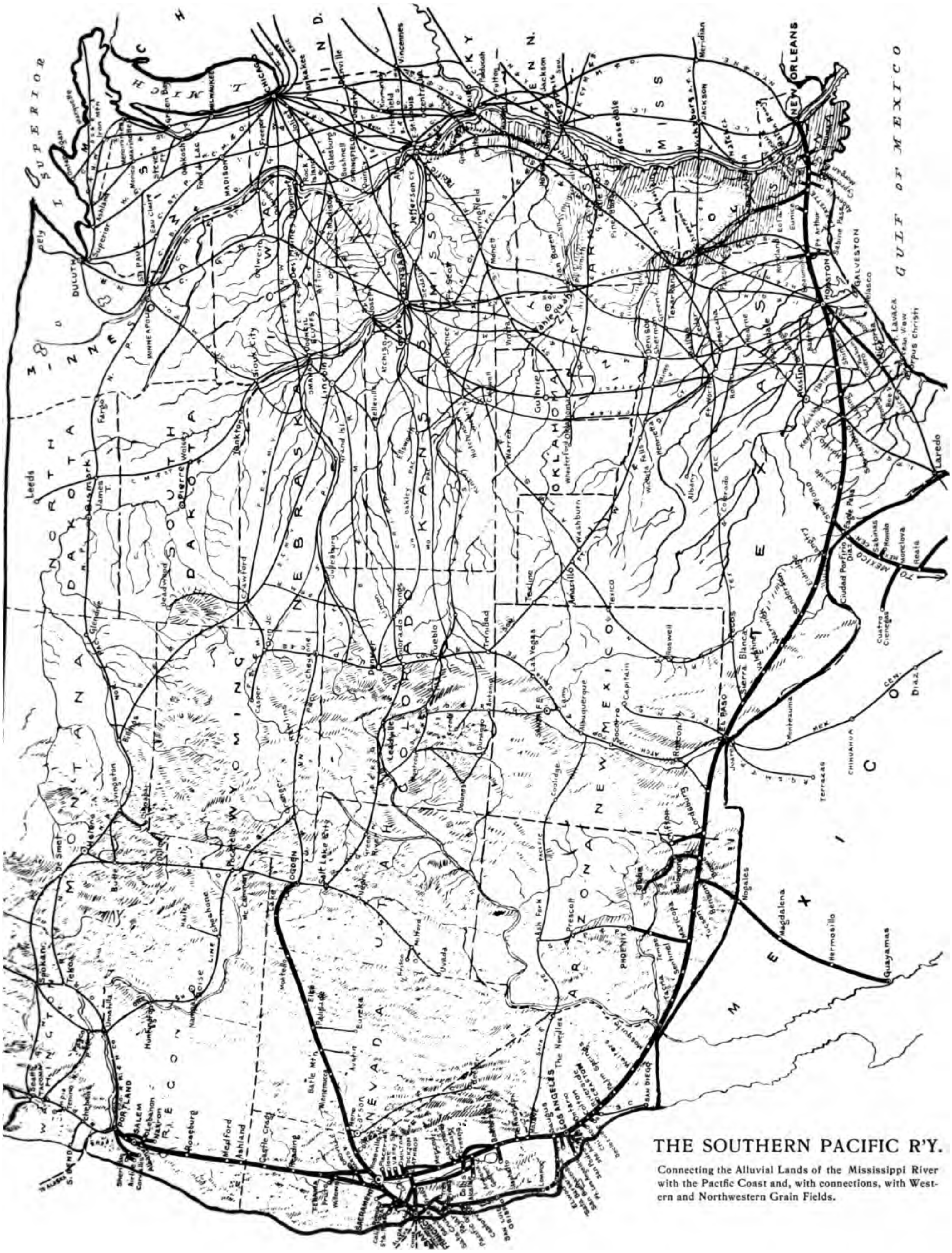


THE PORT OF NEW ORLEANS



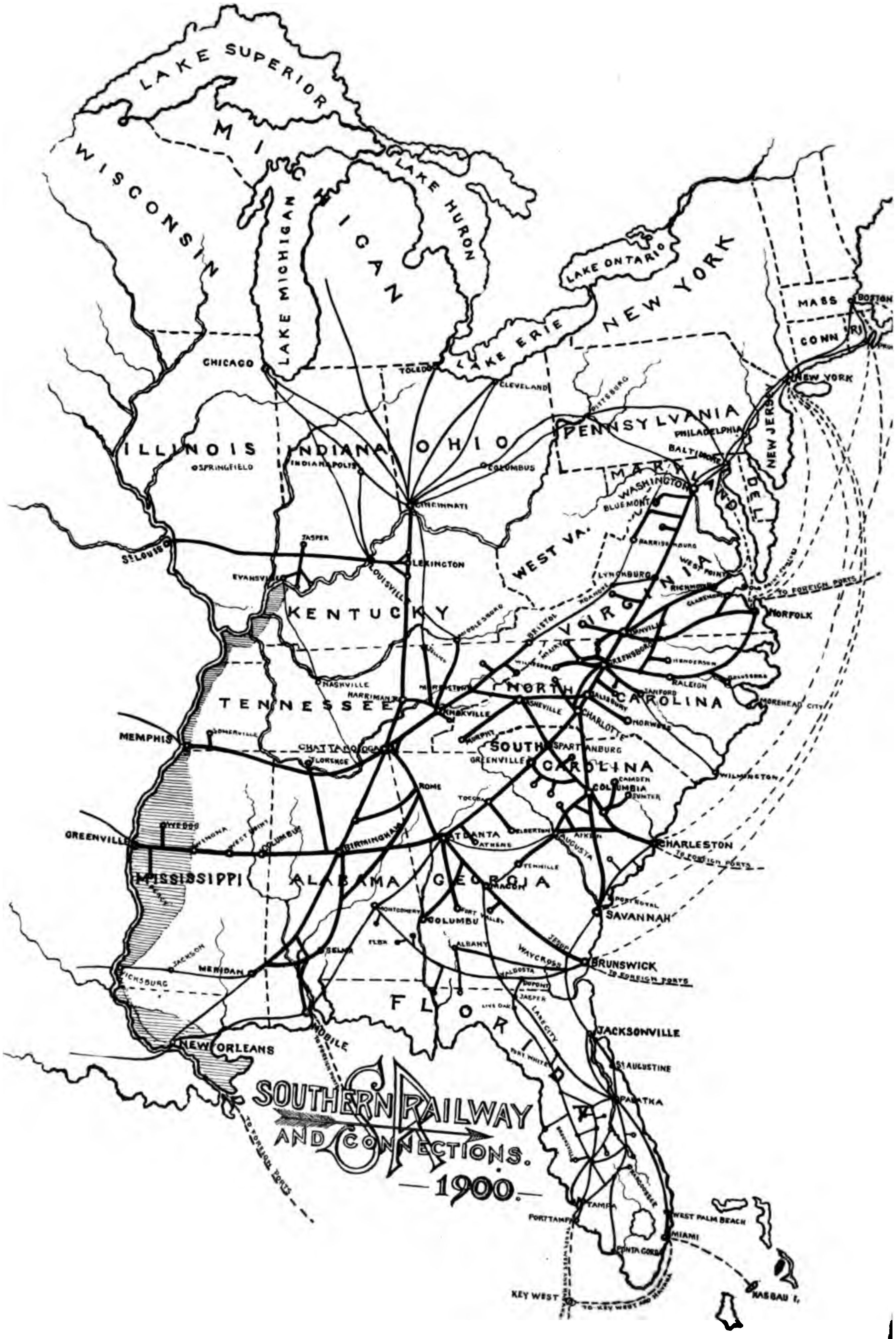
ILLINOIS CENTRAL
AND
Y. & M. V. R R SYSTEM

With Northern and Eastern Through Connections showing artries which link the Alluvial Lands of the Mississippi River with Commercial and Industrial Centers of The North and East.

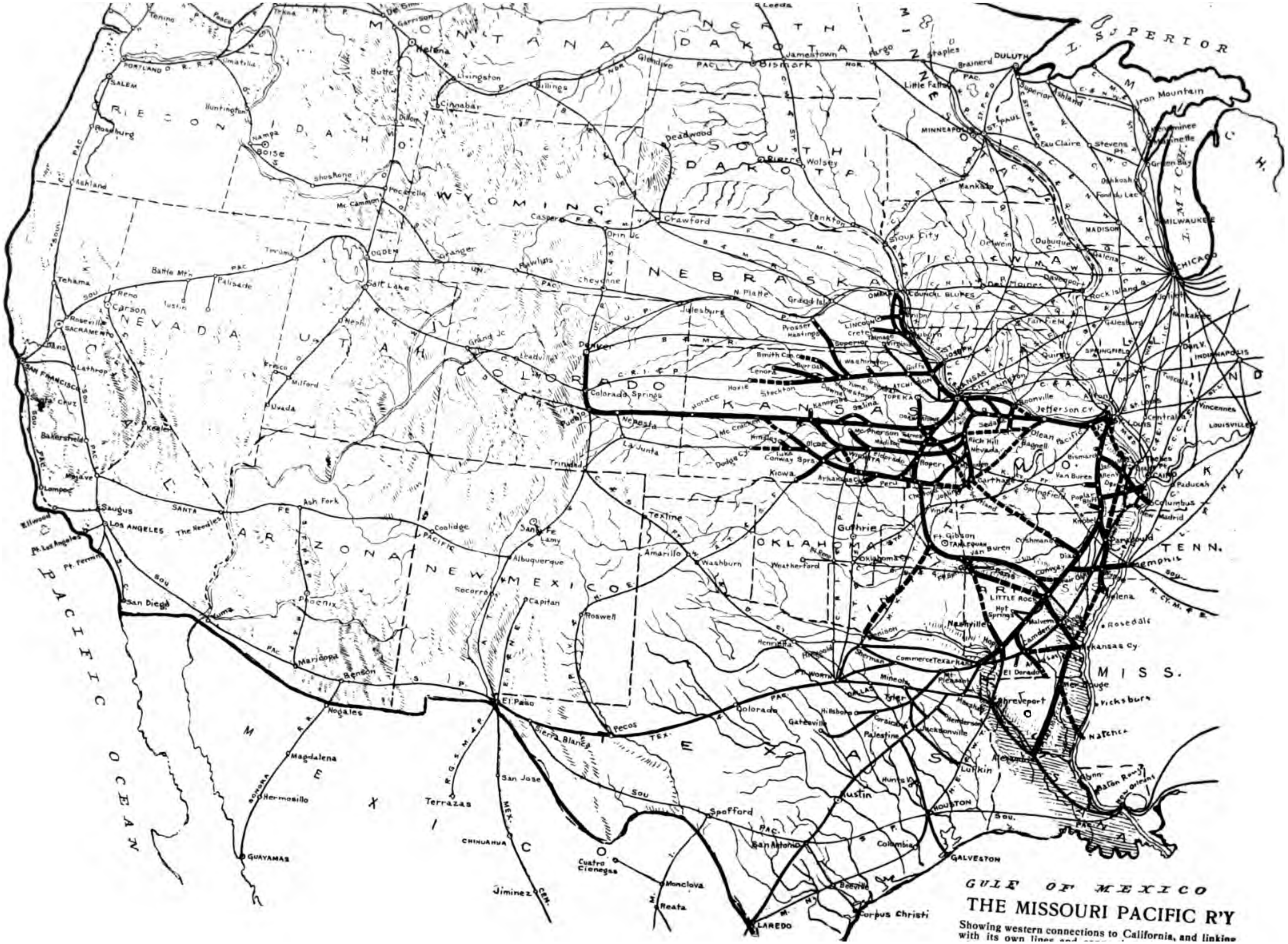


THE SOUTHERN PACIFIC R'Y.

Connecting the Alluvial Lands of the Mississippi River with the Pacific Coast and, with connections, with Western and Northwestern Grain Fields.



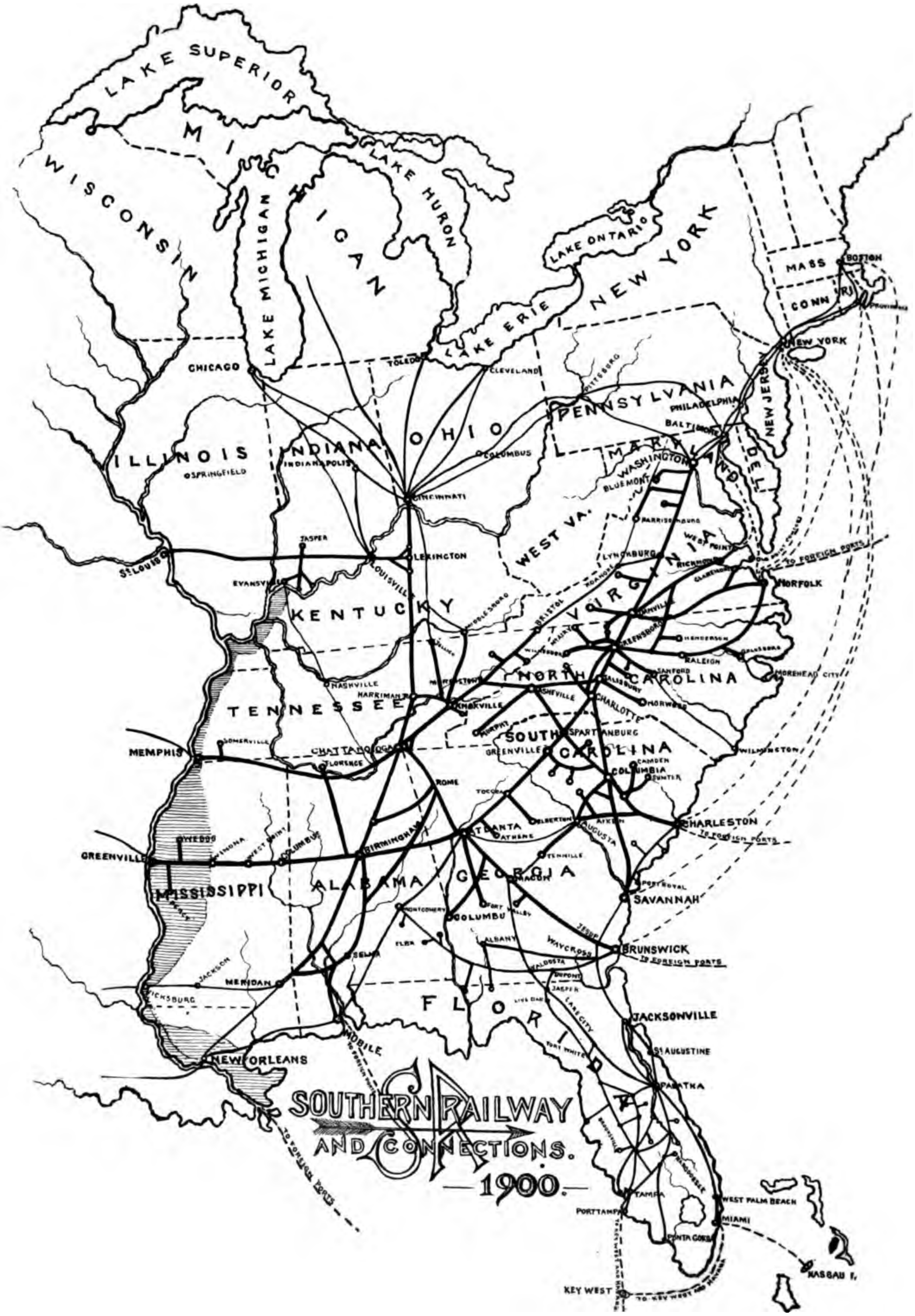
SOUTHERN RAILWAY AND CONNECTIONS. —1900.—

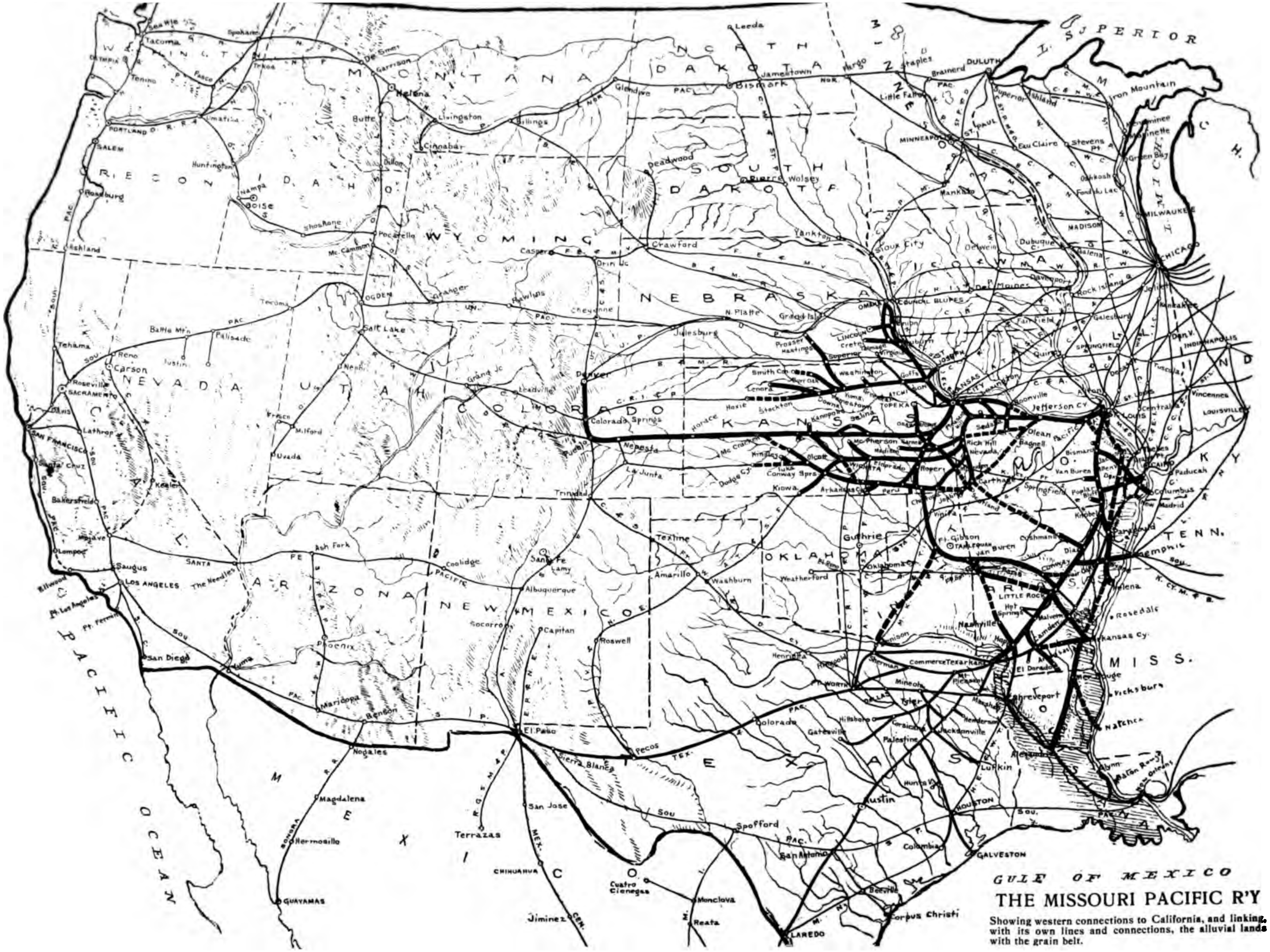


GULF OF MEXICO

THE MISSOURI PACIFIC R'Y

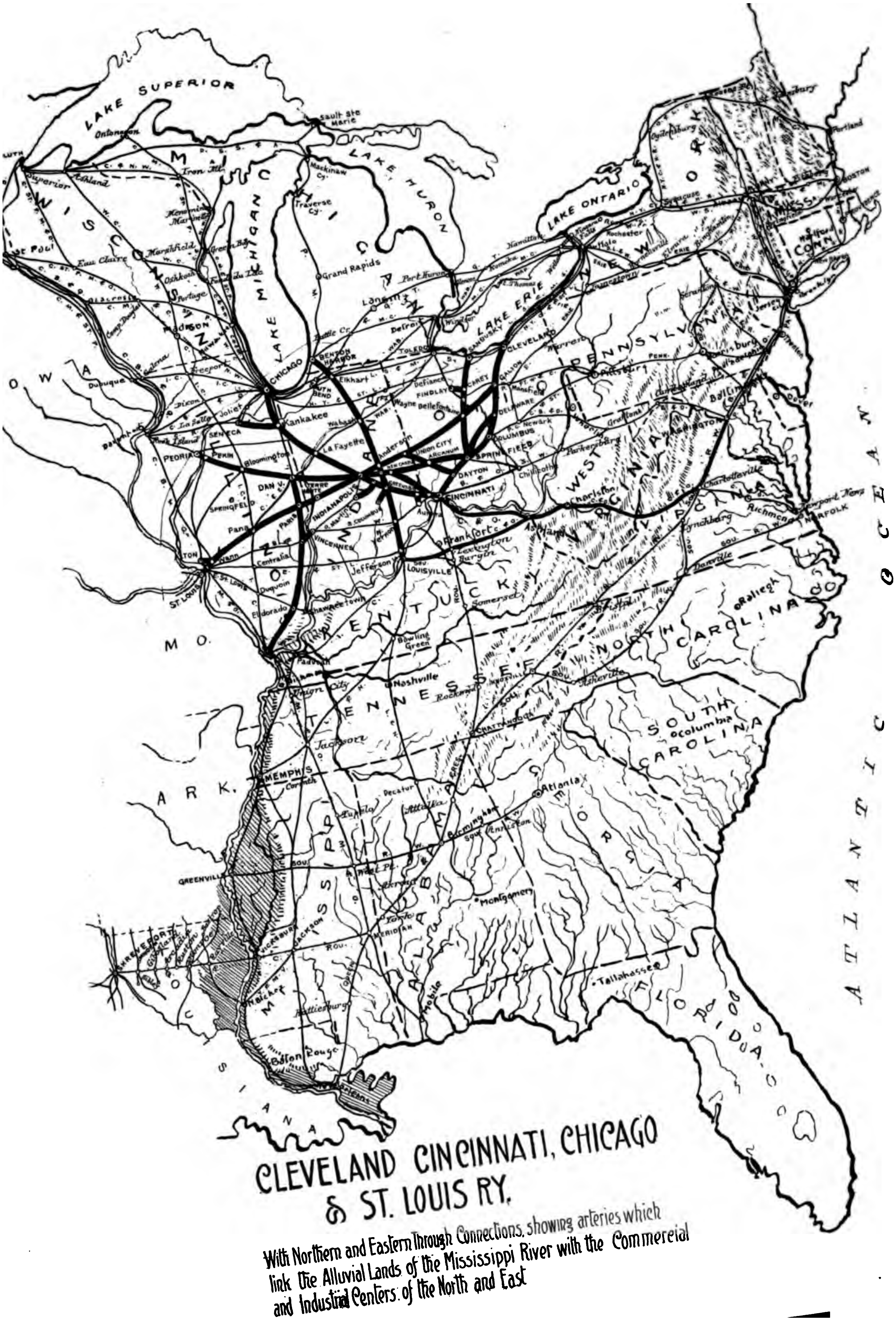
Showing western connections to California, and linking with its own lines and


SOUTHERN RAILWAY
AND CONNECTIONS.
—1900.—
LAKE SUPERIOR
MICHIGAN
WISCONSIN
LAKE MICHIGAN
LAKE HURON
LAKE ONTARIO
LAKE ERIE
NEW YORK
MASS
BOSTON
CONN
R.I.
PROVIDENCE
NEW YORK
NEW JERSEY
PENNSYLVANIA
PHILADELPHIA
PITTSBURG
BALTIMORE
MARYLAND
DEL
WASHINGTON
BLUEMONT
CHICAGO
TOLEDO
CLEVELAND
OHIO
COLUMBUS
INDIANA
INDIANAPOLIS
ILLINOIS
SPRINGFIELD
CINCINNATI
WEST VA.
HARRISONBURG
WEST POINT
LYNCHBURG
RICHMOND
NORFOLK
TO FOREIGN PORTS
ST. LOUIS
JASPER
EVANSVILLE
LOUISVILLE
LEXINGTON
KENTUCKY
MIDDLESBORO
BRISTOL
VIRGINIA
DANVILLE
GREENSBORO
HENDERSON
RALEIGH
SANFORD
MOREHEAD CITY
NORTH CAROLINA
SALISBURY
ASHEVILLE
CHARLOTTE
NORWOOD
NASHVILLE
HARRIMAN
KNOXVILLE
TENNESSEE
MORRISTOWN
MURPHY
SOUTH CAROLINA
SPARTANBURG
GREENVILLE
CAMDEN
COLUMBIA
SUMTER
WILMINGTON
MEMPHIS
SOMERVILLE
CHATTANOOGA
FLORENCE
ROME
TOCCOA
ATLANTA
ATHENS
ELBERTON
AIKEN
AUGUSTA
CHARLESTON
TO FOREIGN PORTS
TENNILLE
GREENVILLE
WEBB
WINONA
WEST POINT
COLUMBUS
BIRMINGHAM
MISSISSIPPI
ALABAMA
GEORGIA
MACON
FORT VALLEY
PORT ROYAL
SAVANNAH
MONTGOMERY
COLUMBUS
ALBANY
JESUP
SELMA
WAYCROSS
BRUNSWICK
TO FOREIGN PORTS
VALDOSTA
DUPONT
JASPER
LAKE CITY
FORT WHITE
JACKSON
MERIDIAN
VICKSBURG
FLORIDA
JACKSONVILLE
ST. AUGUSTINE
MOBILE
NEW ORLEANS
PALATKA
TO FOREIGN PORTS
TAMPA
PORT TAMPA
WEST PALM BEACH
MIAMI
PUNTA GORDA
NASSAU I.
KEY WEST
TO KEY WEST AND HAVANA



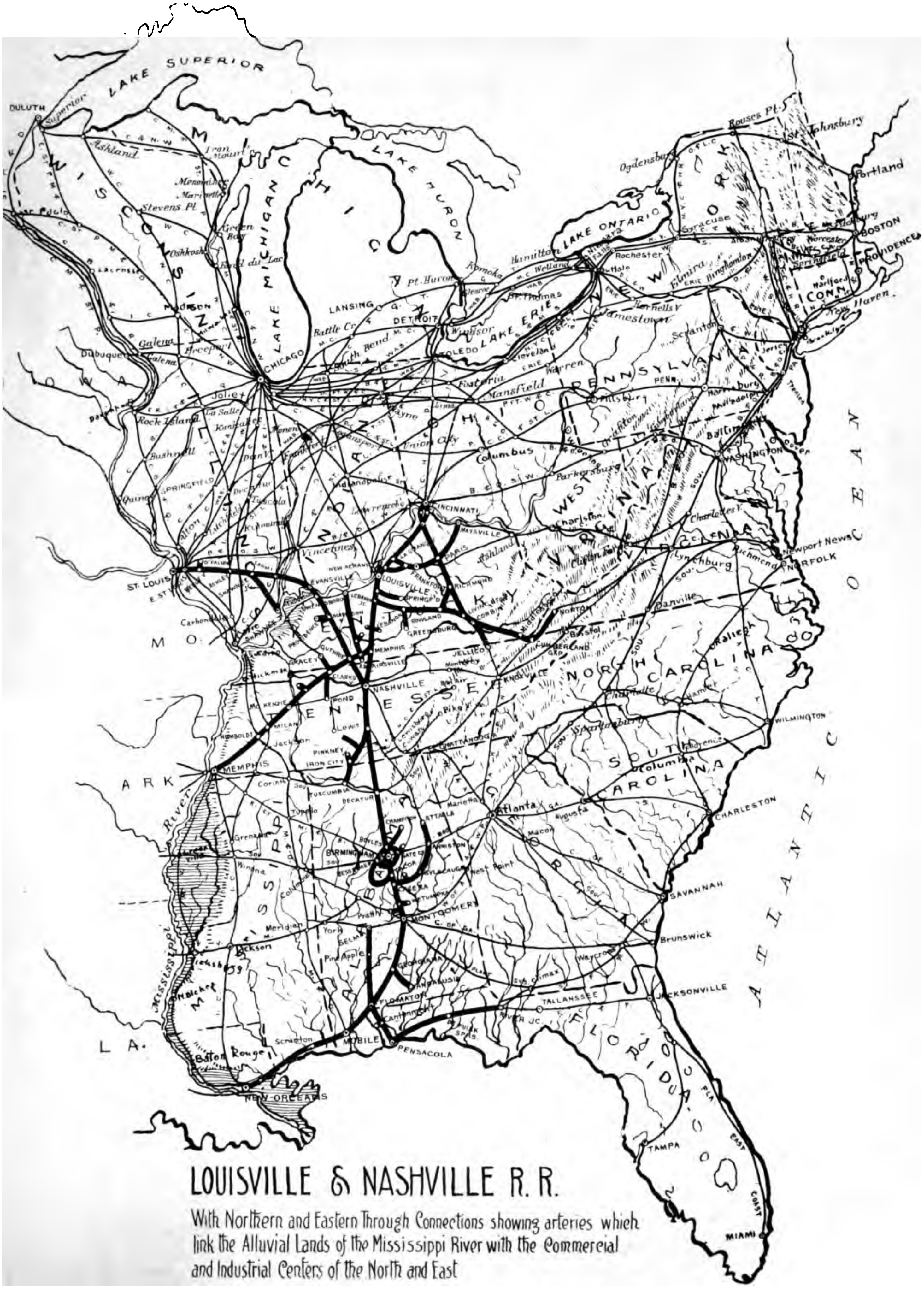
THE MISSOURI PACIFIC R'Y

Showing western connections to California, and linking, with its own lines and connections, the alluvial lands with the grain belt.



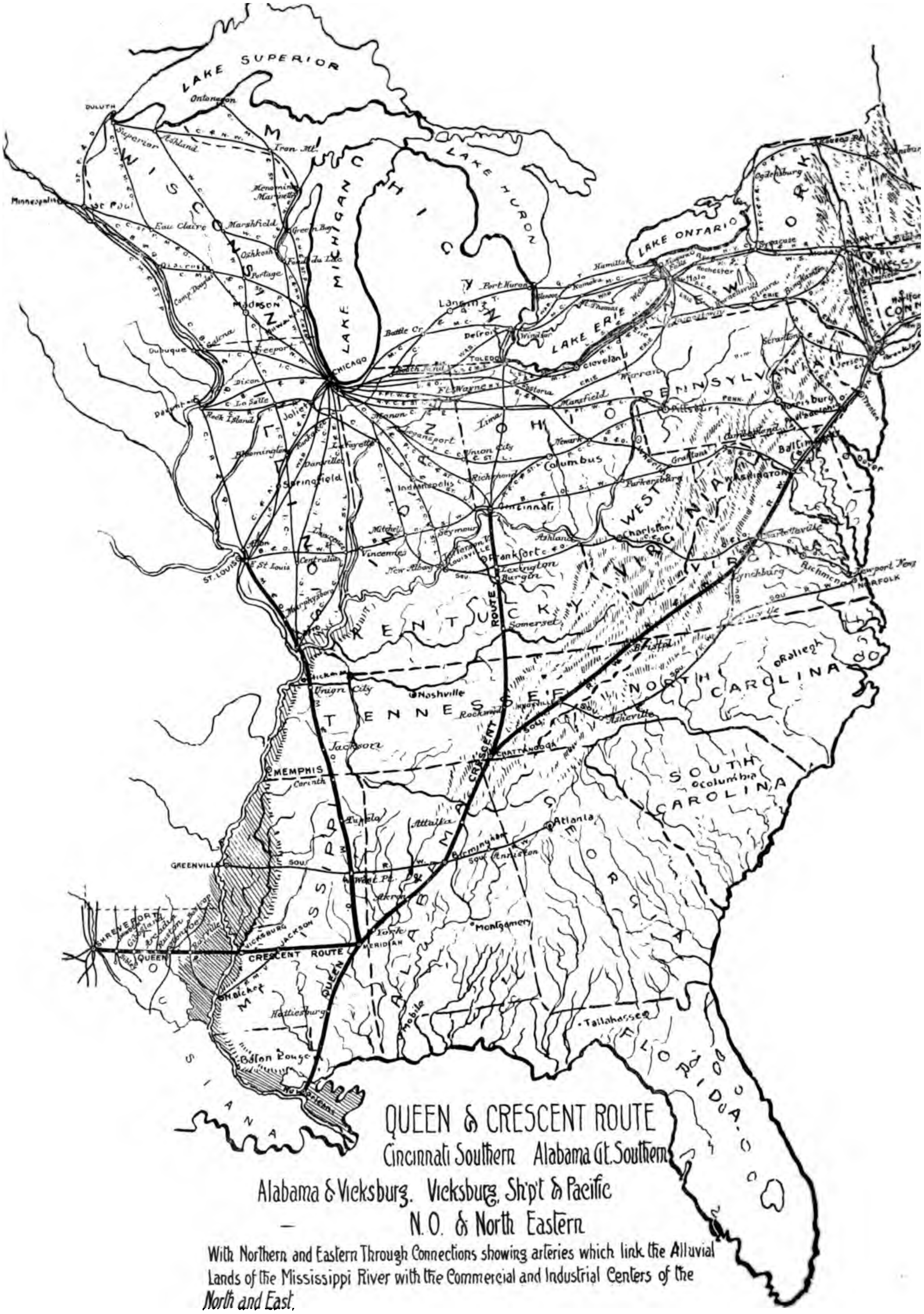
CLEVELAND CINCINNATI, CHICAGO & ST. LOUIS RY.

With Northern and Eastern Through Connections, showing arteries which link the Alluvial Lands of the Mississippi River with the Commercial and Industrial Centers of the North and East



LOUISVILLE & NASHVILLE R. R.

With Northern and Eastern Through Connections showing arteries which link the Alluvial Lands of the Mississippi River with the Commercial and Industrial Centers of the North and East



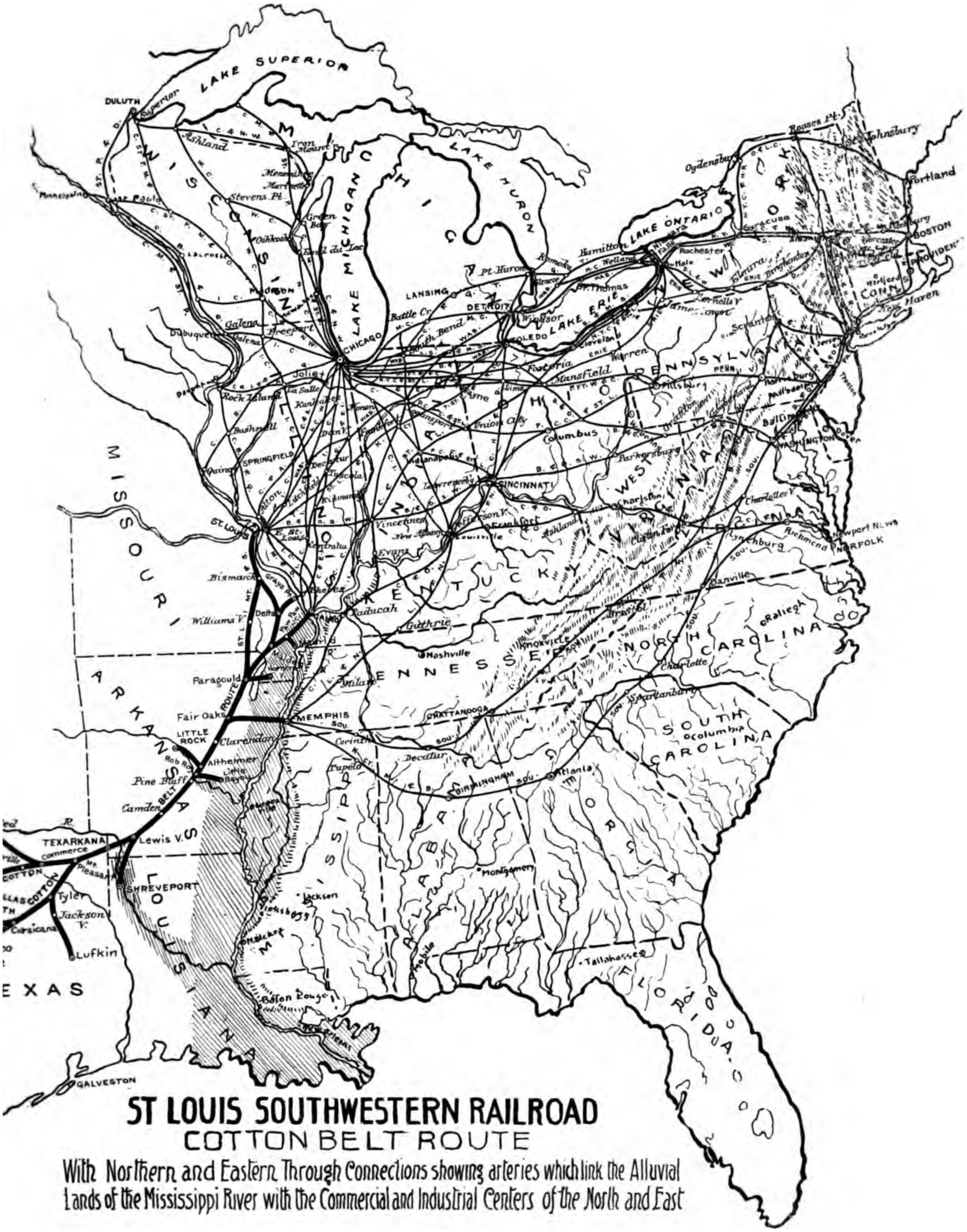
QUEEN & CRESCENT ROUTE

Cincinnati Southern Alabama Gt. Southern

Alabama & Vicksburg. Vicksburg, Sh'p't & Pacific

— N.O. & North Eastern

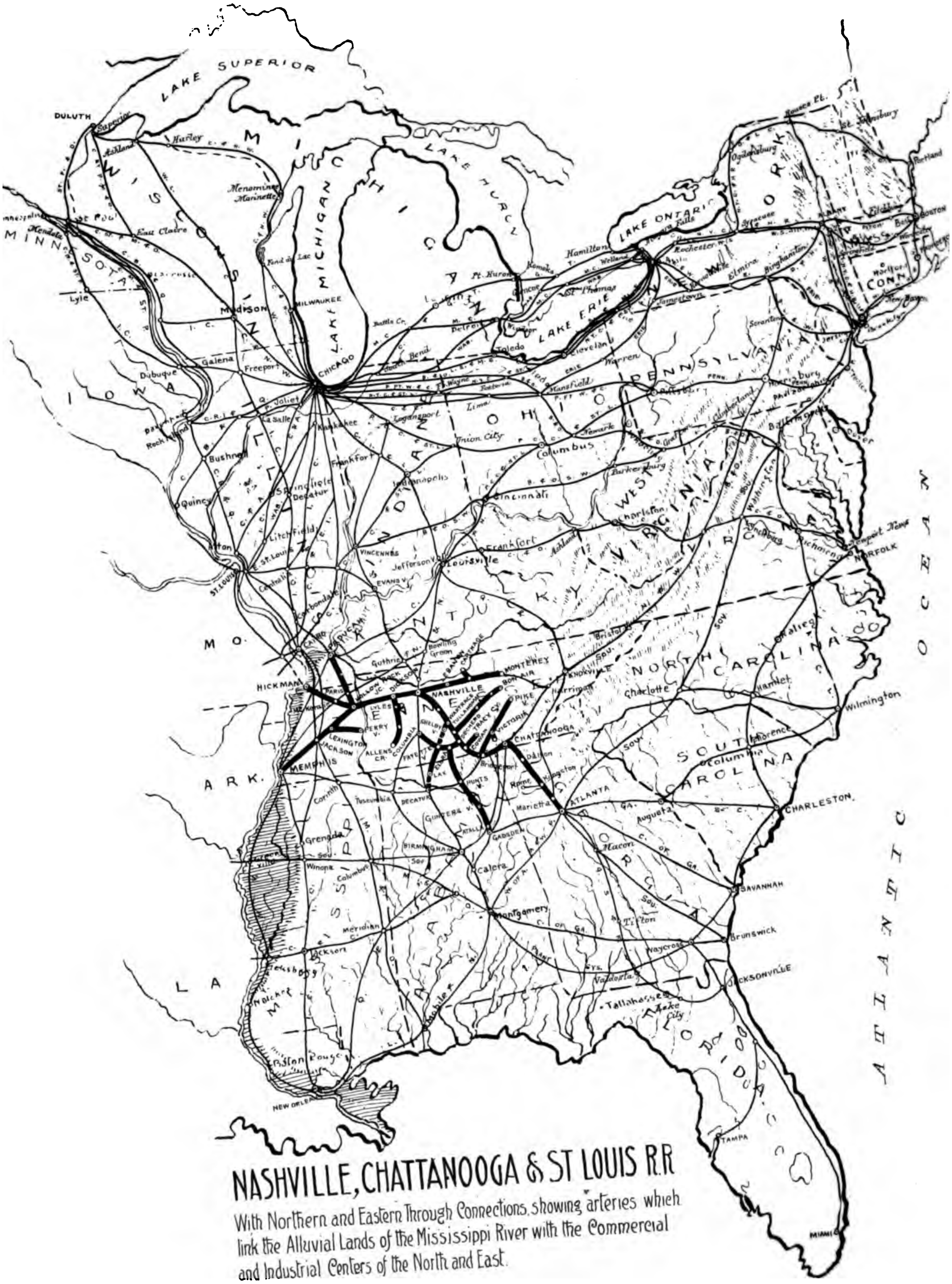
With Northern and Eastern Through Connections showing arteries which link the Alluvial Lands of the Mississippi River with the Commercial and Industrial Centers of the *North and East.*



ST LOUIS SOUTHWESTERN RAILROAD

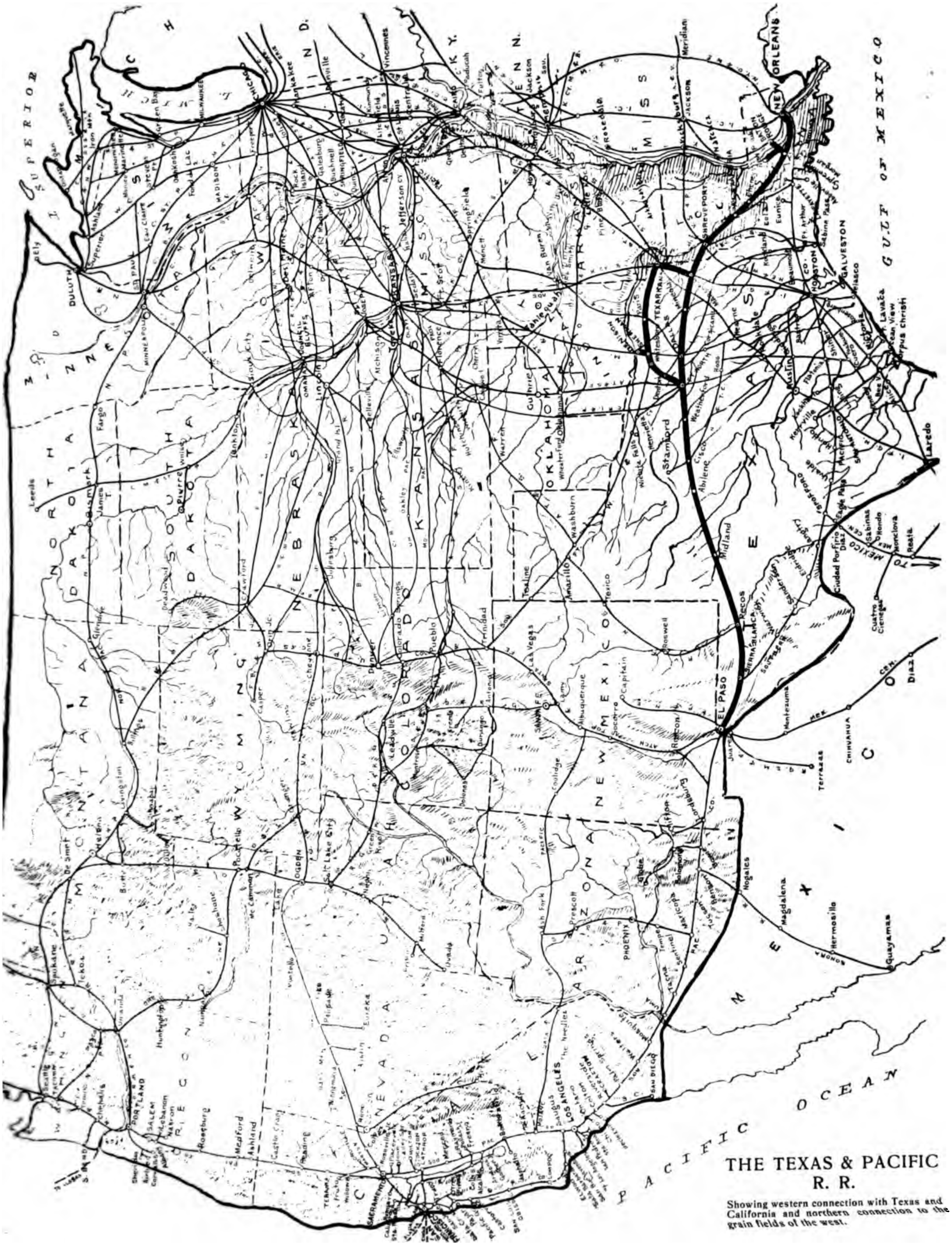
COTTON BELT ROUTE

With Northern and Eastern Through Connections showing arteries which link the Alluvial Lands of the Mississippi River with the Commercial and Industrial Centers of the North and East



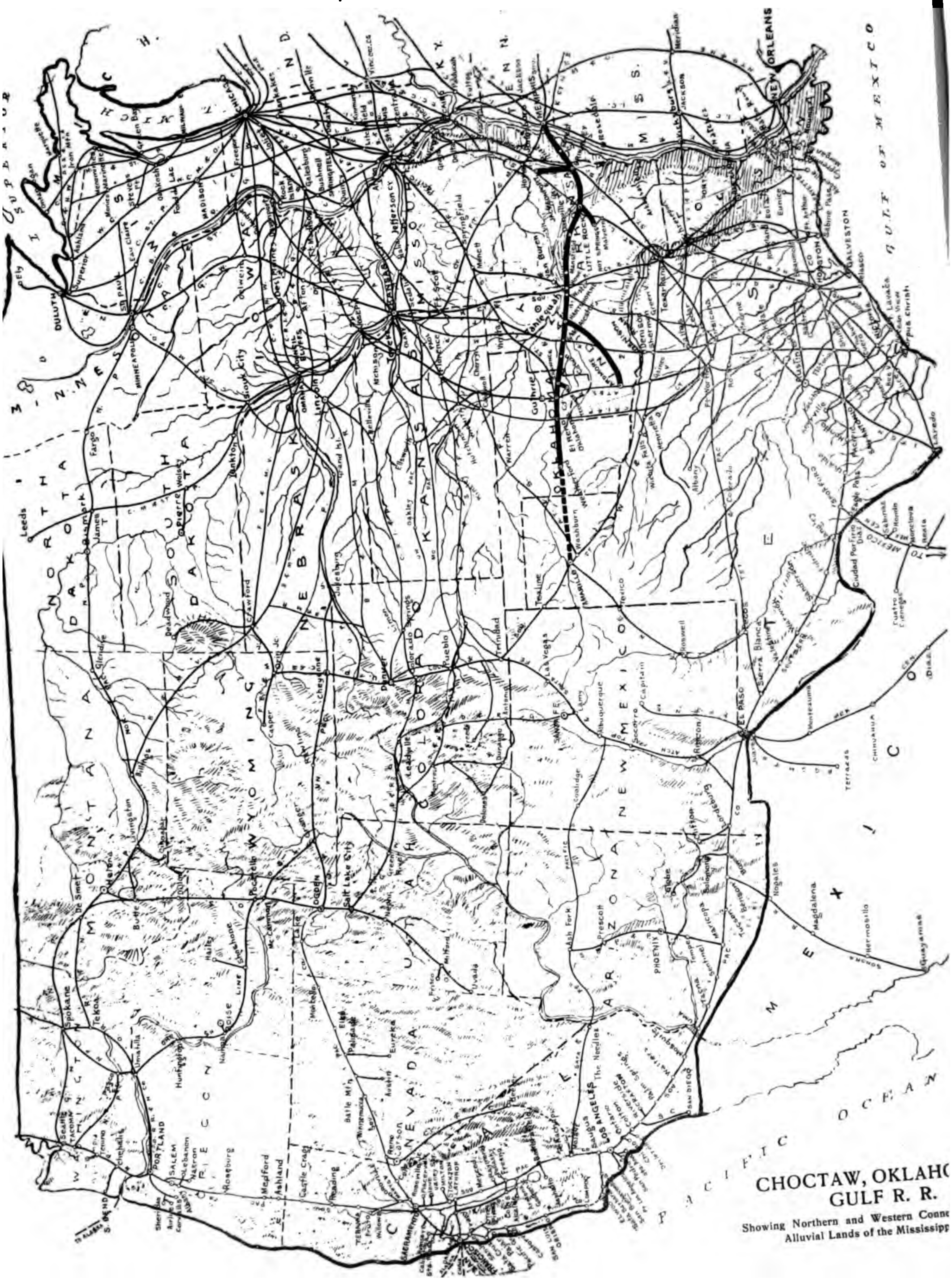
NASHVILLE, CHATTANOOGA & ST LOUIS R.R

With Northern and Eastern Through Connections, showing arteries which link the Alluvial Lands of the Mississippi River with the Commercial and Industrial Centers of the North and East.



THE TEXAS & PACIFIC
R. R.

Showing western connection with Texas and California and northern connection to the grain fields of the west.

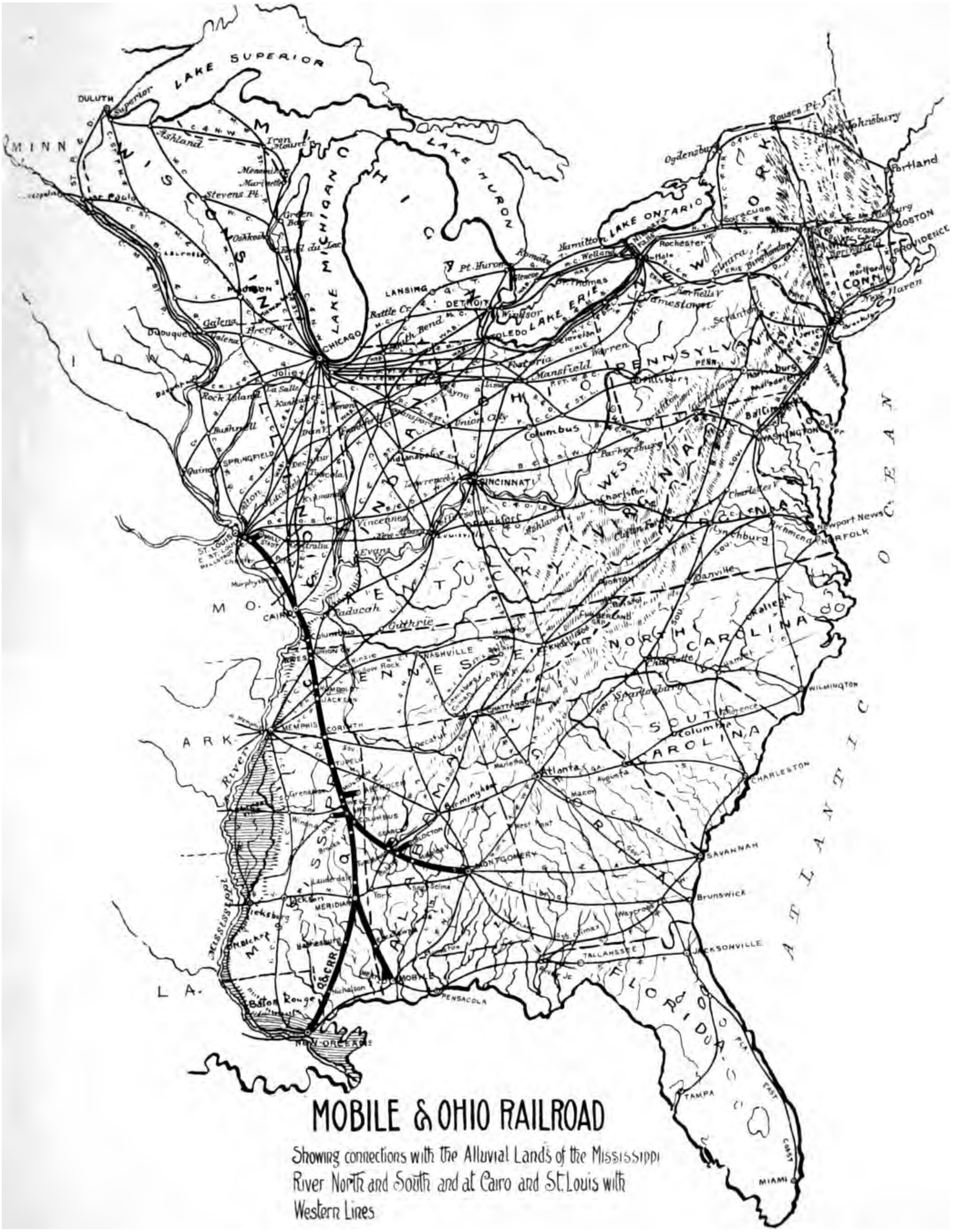


CHOCTAW, OKLAHO

GULF R. R.

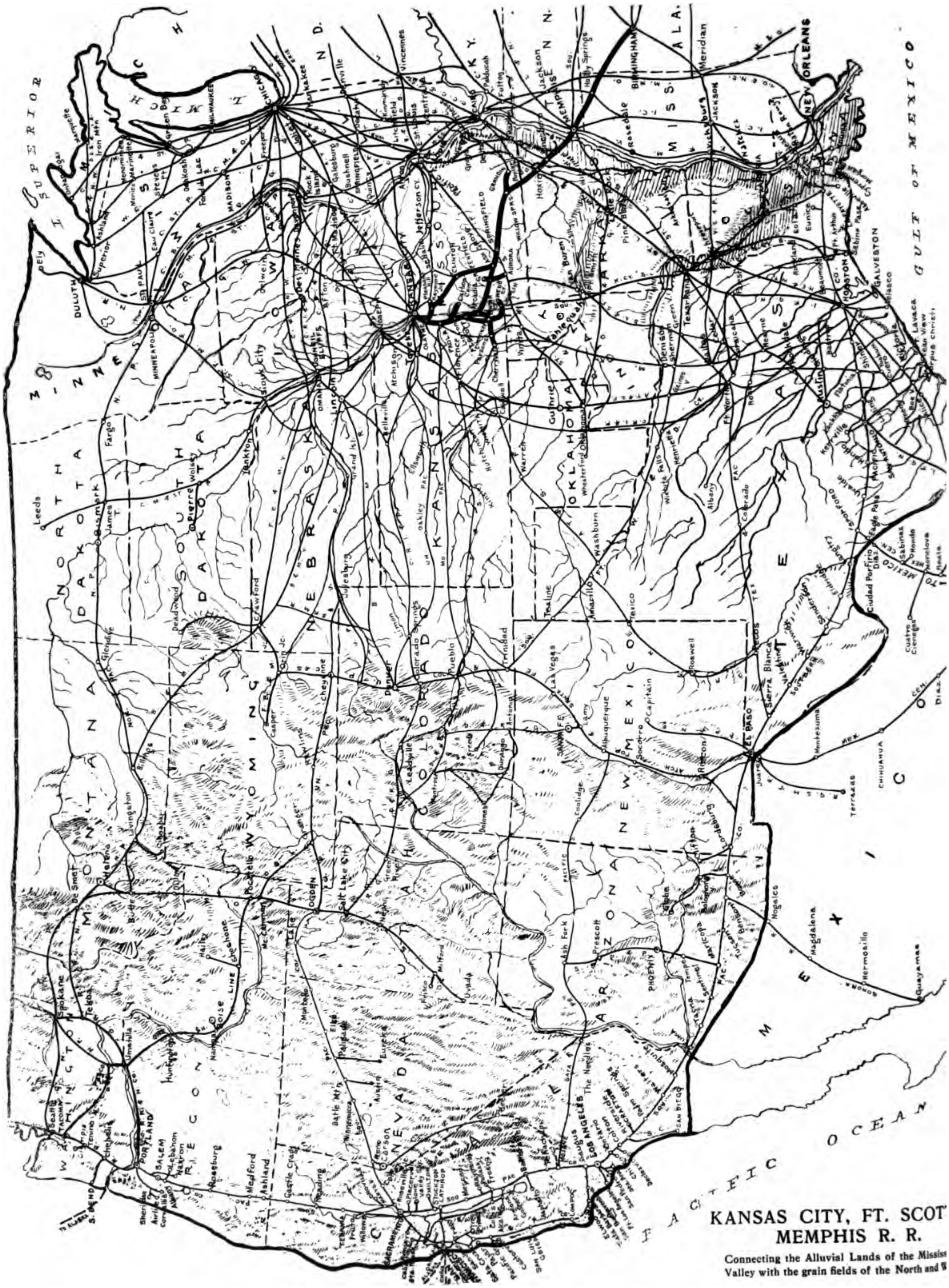
Showing Northern and Western Conne

Alluvial Lands of the Mississipp



MOBILE & OHIO RAILROAD

Showing connections with the Alluvial Lands of the Mississippi River North and South and at Cairo and St. Louis with Western Lines



KANSAS CITY, FT. SCOT
MEMPHIS R. R.

Connecting the Alluvial Lands of the Mississ
Valley with the grain fields of the North and W

F. J. Sanders.

DEEP WATER

BY M. J. SANDERS, PRESIDENT N. O. MARITIME ASSOCIATION

The great and glorious River Mississippi, the Father of Waters, has ever exerted a paramount influence upon the development and welfare of our great country, and though our land is fast being covered with a closely woven network of railroads, the importance of the great river has never, and will never cease to be felt by our Nation. Even whilst neglected, its channels allowed to fill up, and its navigation of a precarious and unsatisfactory nature, little used and carrying upon its bosom but a small fraction of the country's trade, its direct, positive influence upon the economy of transportation, saved the farmers and manufacturers of the great valley millions of dollars annually. Congress has in recent years liberally appropriated money for the betterment of its navigation and in the near future we shall doubtless see the great stream working out its beneficent destiny as the great economical highway from the farms and factories of the great West to the shore of the distant Gulf.

Satisfactory water transportation always has proved and always will prove more economical than any other form yet known, and for such purpose there is no river in the world so important and capable of such great and beneficent influence as the great natural highway of the United States.

The commercial utility as a means of transportation of the River Mississippi and its tributaries is, however, still in its infancy. The money expended by Congress to improve the navigation of this great system of waterways has scarcely yet borne any extraordinary results, but that it will soon do so and that still greater sums of money will be spent to advantage on these streams is a certainty. The thousands of miles of waterways of the river and its tributaries, which, in like manner to the great arterial system in the human body, ramify throughout more than one-half of the states of the Union, furnish God-given possibilities, almost beyond the conception of man, and the wildest imagination of great engineers has never yet been able to more than outline the future possibilities of this great waterway system, which is destined to prove the great safeguard and economical transportation factor in the welfare of the teeming, toiling millions, who shall cultivate the soil of the fertile valleys, build great cities upon its banks, and manufacture there the necessaries of life for a very large portion of the whole world. The money the country has as yet expended, and the results that have thereby been gained, are but as a drop in the bucket, compared with that which lies before us in the future. That the mouth of this great river should be properly cared for and that its channels should ever afford safe navigation for the fleets of the world engaged in the peaceful beneficence of commerce requires no argument.

There is no apparent finality in human affairs. What our ancestors of old considered satisfactory and thoroughly modern, our fathers scouted as ridiculous and insufficient, and we in turn consider the requirements, knowledge and customs of our fathers as belonging to an unsatisfactory past; so doubtless our sons will marvel how we were contented in our narrow and undeveloped surroundings and lack of, what will be to them, the common necessities of life.

We realize very clearly this thought in contemplating the evolution of the ocean freight carrier with its economic results, the consideration of which is largely the purpose of this article and which is the essential factor in the intercourse between our own and other nations, and is a most practical and forcible illustration of the absence of finality.

I shall endeavor briefly as possible to show the development of the modern ocean carrier and its close relation to the improvement and development of rivers and harbors with the economic and beneficial effects upon the welfare of our people resulting therefrom.

Twenty years ago the only channel of value to commerce from the main stream of the Mississippi River to the ocean was through the Southwest

M. J. DEMPSEY

THOS. J. WOODWARD

J. A. JONES

A. K. MILLER

W. P. ROSS

M. WARRINER

GEO. R. BAGLEY

Resident City Engineer.

Pass, having then over the bar at its mouth to the Gulf of Mexico a depth of water of some seventeen to eighteen feet. Necessarily the ocean vessels trading to the port of New Orleans at that time, and using this channel, were of a very limited size and capacity, owing to this limited depth of water in the channel.

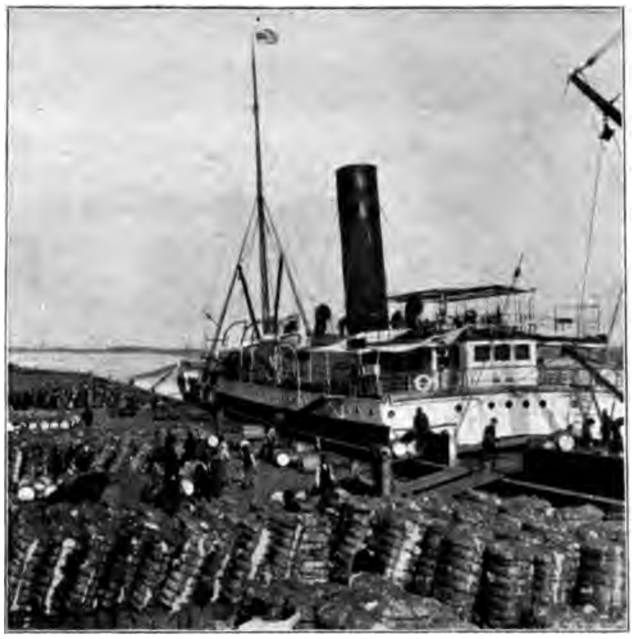
The largest sized vessel at that time had a capacity of some 2,000 tons dead weight, or carried about 6,000 bales of compressed cotton. It was quite a common occurrence for these vessels, small as they were, to get aground on the bar at the mouth of the Pass when proceeding to sea, and many have lain three or four weeks until they were assisted over the bar to the deep water beyond, either by means of dredges or the natural effect of the current of the river.

All this was the cause of heavy expense to those vessels trading to the port, while the limited size of the vessels, which under the most favorable circumstances could safely navigate this channel, seriously affected the volume of imports and exports, through the port of New Orleans, and maintained ocean transportation rates on a high basis, so that ports more favored in the matter of navigable channels, and thereby admitting large vessels, were rapidly diverting the trade naturally belonging to the port at the mouth of the great river.

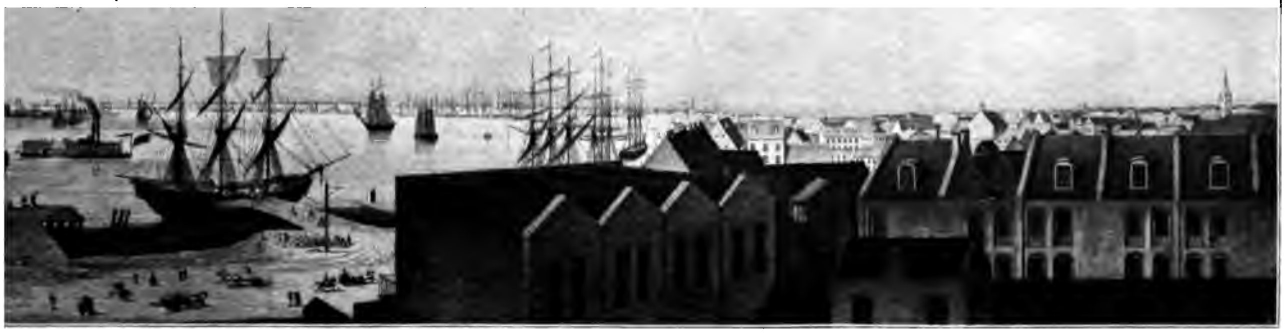
Much money was spent by the Government in the effort to deepen and improve the channel at the Southwest Pass by means of dredges and screw propellers but without any permanent success, as a channel made to-day would inevitably be filled, and by to-morrow, all trace of yesterday's work completely lost through the immense amount of sediment which the river carries in its waters, which is precipitated with great rapidity when anything interposes to check the onward rush of the current. Able engineers gave the matter their attention and numerous theories for overcoming the difficulty were propounded, but finally the first definite step toward the much-needed improved channel was attained by James B. Eads, who, in March, 1875, obtained from Congress a contract, whereby he agreed to provide a channel having a central depth of 30 feet through the South Pass from deep water in the Mississippi River to the Gulf of Mexico. At that time the South Pass was unused, being scarcely more than a good sized ditch and, it was felt by those who opposed Mr. Eads, that if he did no good, he could certainly do no harm, as the pass given him was useless anyway. Mr. Eads's contract was on the "no cure, no pay" system, and it was understood that he proposed to make his channel by the use of mattresses and bulkheads in the pass itself, thereby contracting the width of the pass and at the sea end, by the use of jetty walls, extending the banks of the pass into deep water, thus confining the current and forcing it by its own velocity not only to carry out its sediment into deep water in the Gulf, but also to clean out and maintain the channel through the whole length of the pass. Whether Mr. Eads's original plans were or were not carried out; whether he ever originally intended to use dredges at all; or whether the system of jetties alone or jetties and dredges combined, has been proved the correct solution of this great engineering problem, it does not befit me to comment upon. That question is one for engineers alone, and of them, only such as have for years studied such problems are entitled to authoritatively speak.

That Mr. Eads had to modify his original plans somewhat is very probable, and that he obtained from Congress a concession as regards the dimensions of the channel originally agreed upon through the South Pass, is on record. However, Mr. Eads certainly was eminently successful in obtaining a good navigable channel of 26 feet through the entire length of the pass, and an even greater depth between the jetties and out to deep water in the Gulf. Thus, by his work, a useless pass of irregular width and having in places as little as 9 feet of water was made for 12 miles long of a depth of 26 feet, which depth has usually been maintained, with the exception of periods during high water, when sand waves enter the pass and seriously shoal the channel. This makes its navigation at times dangerous and disastrous to vessels drawing as little as even 23 feet of water.

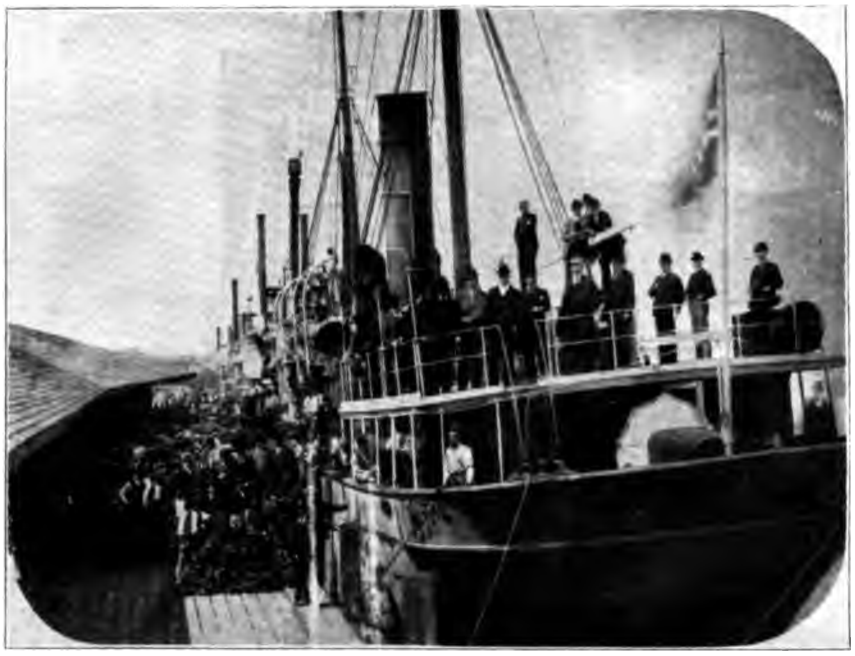
No sooner was the South Pass opened with a channel of 26 feet depth than the average size of the vessels trading to the port at once showed a marked increase and by reason of the increased economy of this larger tonnage, the cost of ocean transportation rapidly decreased. Thus, while the largest vessel using the old Southwest Pass had a capacity of only about 6,000 bales of cotton, within a few years of the opening of the South Pass, vessels having a capacity of 4,000 tons dead weight



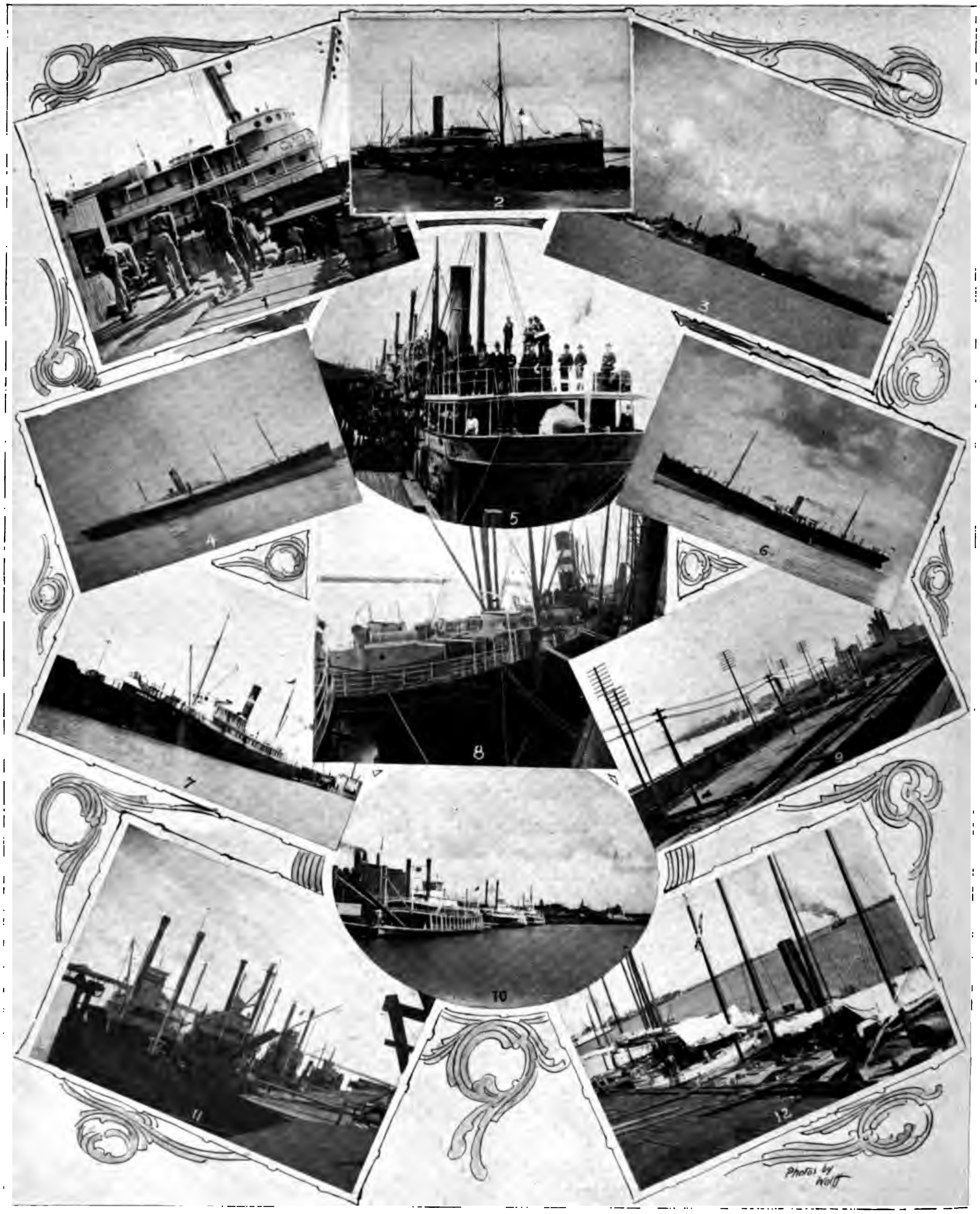
LOADING COTTON AND OIL



NEW ORLEANS IN 1850—FROM AN OLD GERMAN PRINT



UNLOADING A BANANA SHIP



SHIPPING SCENES—PORT OF NEW ORLEANS

and able to carry 12,000 bales of cotton were regularly engaged in the trade to New Orleans.

Previous to the opening of the South Pass the rate of freight on cotton from New Orleans to Liverpool was about 1½c. per pound, or $7.90 per bale. Shortly after the opening of the South Pass, in 1880, the average rate decreased to ¾ of one cent per pound, or $3.90 per bale.

During the ten years following the opening of the new channel through the South Pass about one and one-half million bales of cotton per annum passed through this channel, making evident an annual saving in ocean transportation on this cotton alone of about six million dollars. The saving of ocean freight paid on other commodities which went through the new channel fully equaled this, so that it requires no mathematician nor even a shrewd business man to at once realize that, though it has cost the country about ten million dollars to open and maintain for the past twenty years the channel through the South Pass, the annual saving to the producer in the cost of transporting his goods to the markets across the ocean has equaled the total cost of the improvements and maintenance. These figures sound fabulous and, except to the initiated, grossly exaggerated, but it must be remembered that the channel through the mouth of the great River Mississippi is of such enormous commercial value that, however great the sum properly spent upon its improvement and maintenance, the return is bound to far exceed the cost.

Since Congress so wisely decided upon the opening of a new channel at the mouth of the river, other important factors have come into play, still further affecting the economy of ocean transportation. Principal amongst these is the evolution (amounting almost to a revolution) of the modern ocean Leviathan.

Previous to 1890 the growth in size of ocean steamers had been quite gradual, in fact for several years previous the size of ocean vessels had (outside of a few passenger steamers) increased only slightly, but about that year one or two steamers made their appearance, destined for trade between the United States and Great Britain, distinctly of much greater cargo capacity than anything then afloat. It was soon seen that the economy and commercial success of the new large freighters over their competitors was enormous, and at once began in shipping the remarkable era of the past ten years, during which more advance in the size of ocean freighters has been made than in fifty years previous. Vessel after vessel was built, each having an enormously increased capacity over its predecessor, until even the wide awake shipowner held his breath and enquired, "When is it going to stop?" Whereas a steamer of 4,000 tons capacity was ten years ago quite large, to-day one hears without wonder of vessels building whose capacity is 16,000 tons, and still there is no evidence of finality. At first it was supposed that the development would end when the vessels had reached the maximum size which the principal ports in the world could accommodate, as of course the larger vessels are not only longer and broader, but much deeper than the vessels of ten years ago, and the depth of channels, width of dock gates, and length of quays and wharves all had to be taken into account.

It was known that the expense of enlarging channels and altering massive masonry, such as the dock gates and docks necessary in tidal harbors are built of, would be enormous, and few realized that even this difficulty would not seriously retard the increasing size of the ocean carrier. It required but a few years' experience, however, to convince business men the world over that the big carrier was not only an assured success, but practically irresistible as an economizer, and the ports both in this and other countries began at once to arrange for such improvements as would enable them to accommodate the "Ocean Monsters," so that their more favored rivals might not outstrip them in the ceaseless competition of commerce.

The United States has ever been to the forefront in the matter of harbors and up-to-date port facilities, and as a consequence this country has undoubtedly the lion's share of the most economical form of ocean transportation. But the finest of our ports required improvement in order to accommodate these enormous vessels and New York, Boston, New Orleans, Philadelphia, Baltimore and all the large ports on the Atlantic and Gulf seaboard have been and are still seeking that assistance from the Federal Government, to which they are entitled, and which is usually so wisely granted by Congress. The port of Liverpool, England, having for years past by far the largest and finest docks system in the world, and upon which some

$100,000,000 have been spent, was not far behind other ports in appreciating the necessity for improvements to even its magnificent docks, and is now working hard to complete a scheme involving the expenditure of some $20,000,000, while other ports in Great Britain, and on the continent of Europe, such ports as Hamburg, Bremen, Antwerp and many others, are spending millions of dollars in harbor, channel and dock improvements.

All this proves most decisively the power of the modern ocean carrier as an economical commercial factor.

The port of New Orleans has for some years past been favored with the most modern of ocean freight carriers and until recently its enormous exports of cotton, grain, lumber, cotton-seed products, etc., have obtained the full benefit of economical ocean transportation.

The past three or four years have, however, served to manifest in a very marked manner the fact that the Eads channel of 20 years ago had become entirely insufficient and very dangerous to modern vessels. Shipowners built vessels for the trade and sent to the port of New Orleans the latest additions to their fleets, knowing the limited depth of water in the channel through the South Pass, but relying upon the volume of cotton, which is a bulky and light freight, to so load their vessels that their draft of water would not be beyond the capacity of the pass. It required but a brief period, however, to demonstrate that not only was the depth of water a factor, but the narrow channel and strong current frequently experienced, made its navigation hazardous in the extreme to the large carriers. Not only were these vessels unable to load in heavy freight above some three-fourths of their capacity, thereby seriously reducing their economical value, but their greater length and breadth caused an immediate increase in the number of vessels grounding in the pass. These occurrences have assumed the most alarming aspect and more than once in the past two years the grounding of these large vessels has seriously threatened the entire destruction of the only navigable channel from the river to the Gulf.

For over three years past a committee appointed by the exchanges and important business interests of New Orleans has been urging upon Congress, through its committees, this danger which threatens South Pass, and the necessity of opening up the Southwest Pass with a wider and deeper channel from the river to the sea. Two years ago Congress, in response to the representations of this committee, appointed a special Board of Engineers with instructions to survey the Southwest Pass and report upon the practicability of opening up that Pass and estimate of the cost thereof. This report was placed before the Rivers and Harbors Committee of Congress in January, 1899, but was not considered by it sufficiently explicit and satisfactory to justify favorable action, and, therefore, another special Board of Engineers was appointed to estimate the cost and prepare a plan for opening up a channel with a depth of 35 feet through the Southwest Pass.

The report of this Board was completed and laid before Congress in January last and states that the pass can be opened and channel of 35 feet in depth by some 1,000 feet width can be made at estimated cost of not over six million dollars. This report will, it is hoped, be received by Congress as satisfactory and sufficient justification for the immediate appropriation of the funds necessary to carry out the report of the Board of Engineers and thereby provide an outlet from the great river to the ocean more suitable to the requirements of commerce and more in keeping with the majesty and importance of the great highway.

At the mouth of the river, the main stream, which is nearly a mile wide, divides into three channels or passes and thus continues its course until its waters, after their ceaseless journey for thousands of miles, find rest in the bosom of the Gulf of Mexico.

The main pass, known as Pass a Loutre, trends away to the eastward and carries an average of 50 per cent of the volume of the main stream, but its channel is so tortuous and unsatisfactory that it has been unused for many years, except by small coasting schooners of very light draft.

The center channel is known as the South Pass and is at present the only one navigable by ocean-going vessels from the main river to the ocean. This was a channel of no account until Mr. Eads, under his contract with the Federal Government, improved it, and even now it carries but an average of some eight per cent of the river's volume to the Gulf.

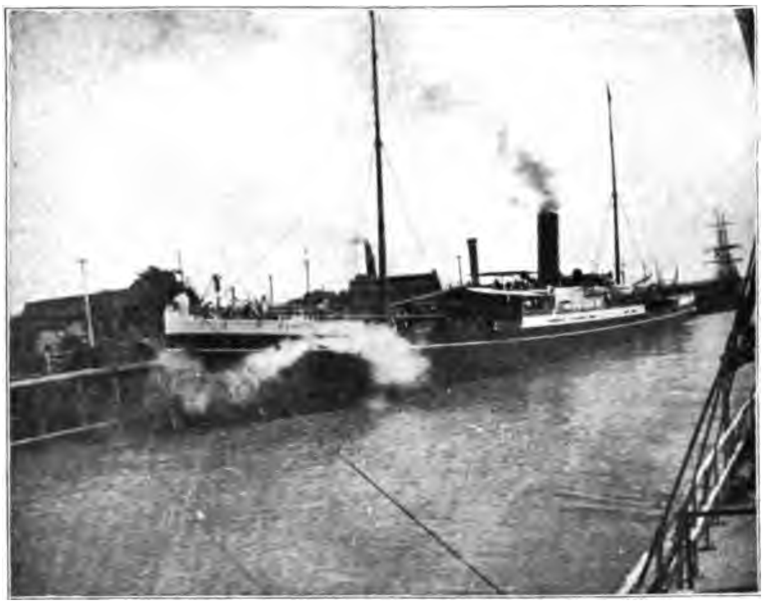
The other and by far the finest and most permanent channel to the ocean is through the Southwest Pass, which carries an average of some 41½ per cent of the volume of the river through its banks to the Gulf of Mexico.

The recent survey by Mr. J. A. Ockerson, made under the direction of the first Southwest Pass Board, is admitted to be most complete, and by comparing it with the several surveys made during the past sixty years it is found that the Southwest Pass is more constant in form and condition than perhaps any other part of the immense river. In the course of over fifty years the greatest alteration observable is its elongation some three miles by the deposit of silt carried down the river, which settles as soon as the current loses its force in the waters of the Gulf.

From just below the mouth of the Red River, 300 miles from the ocean, there is a glorious river, never less than half a mile wide, with a minimum depth at its lowest stage of fifty feet of water, the volume of which reaches the inconceivable magnitude of 2½ million tons of water flowing by a given place every minute, capable of easy and safe navigation by the largest ocean vessel the world has yet, or probably ever will see. Right clear down through the Southwest Pass to within three miles of the Gulf does this unrivaled navigable stream continue unimpeded, requiring no works of man to fit it for the commerce of the great continent, and there is required but the works to converge and control this volume of water so that it may cut its way through the obstruction at its mouth and carry its silt into the vast depths of the ocean beyond. The works of Eads at the mouth of its smallest and least important mouth demonstrate decisively what can be accomplished at the mouth of its most valuable and reliable outlet, and upon this point the able engineers who have so carefully investigated this matter are unanimously agreed.

Let these works be accomplished and the great river will have at last entered upon its beneficent mission as a mighty factor in the welfare of the millions who toil in the immense territory through which it flows, saving to them annually in reduced cost of ocean transportation of their products to the markets of the world more than the total cost of the works of improvement. Commerce will then have thrown open to it its grandest harbor, where Nature herself has done nearly all the work and man is required to do but little, and therefore, expense being avoided, economy will have full sway in helping forward the welfare and the happiness of mankind.

STEAM-SHIP LYING



AT WHARFS OF NEW ORLEANS

E. L. Corthell

THE MOUTH OF THE MISSISSIPPI—VALUE OF DEEP WATER*

BY ELMER LAWRENCE CORTHELL, C. E.

The history of the commercial and naval use of the several mouths of the Mississippi River since the Spanish occupation is exceedingly interesting. The attempts of our Government to deepen the bars by dredging and other means are so well known as a matter of modern history that it is unnecessary to go into details. But a comprehensive or bird's-eye view will, at the outset, be profitable.

The mouth of the Mississippi is the natural outlet, and on the line of least resistance, either by water or by rail, of one of the largest and richest agricultural valleys of the civilized world. It comprises 768,000,000 acres, nearly as large as all Western Europe combined, and capable of supporting as dense a population.

During the ante-bellum period the shallows over the bars at the mouth of the river did not present so great an obstacle to commerce as subsequently. Still, even in 1859 it had become a very serious obstacle, as will be seen from the fact that at one time over $7,000,000 of merchandise was detained there waiting many days to come in or go out. Among the goods thus delayed were 72,000 bales of cotton; a little later there were fifty-five vessels detained at one time.

Coming down to a subsequent period, 1872 to 1877, there were detained at the bar, by grounding or otherwise, 417 vessels; during which period the United States Government made strenuous endeavors, by dredging, to maintain, through the bars at the mouth of Southwest and Northeast passes, 18 feet of water in a narrow channel about one and a quarter miles long.

In 1873 a board of United States army officers was appointed to examine plans for a canal, and was subsequently instructed to report upon the practicability of improving one of the natural outlets of the river.

It reported adversely, January 13, 1874, upon the jetty plan as it was the opinion that the sea ends of the works would be undermined; that the foundations on which the works would rest were unstable, and that there would be an accelerated advance of the bars. The board believed it would be difficult to build or maintain the necessary works. There was, however, a minority report by one member, in which the feasibility of jetties was suggested and the opinion advanced that there were sufficient favorable conditions to at least pause long enough for mature study and investigation, "especially when we weigh the inestimable benefit of an open river mouth."

In May, 1873, Mr. James B. Eads, who had just completed the St. Louis bridge, and had other experience upon the Mississippi River as a builder of ironclads, and in quite extensive wrecking business with a diving bell, visited the mouth of the Mississippi, in company with a large congressional delegation, and at the time unhesitatingly declared that the proper way to remove the obstruction to commerce was by parallel dikes or jetties at the mouth of one of the passes.

In February, 1874, he made a formal proposition to Congress to open the mouth of the river by making and maintaining a deep channel between Southwest pass and the Gulf of Mexico, on the plan of "no cure, no pay."

It is useless, and would be a reflection upon many men who honestly differed with Mr. Eads, both in Congress and out of it, to go into the controversial history of the matter, especially as most of the actors in the drama have passed away. However, the facts of the legislation need to be briefly stated.

The heated controversy led to the passage of a bill authorizing the appointment by the President of a board of seven engineers—three from the army, three from civil life, and one from the United States Coast Survey. The Board went to Europe to personally examine jetties there.

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*From paper written in 1897—*Ed.*

On January 13, 1875, the report of this board was presented to Congress by the Secretary of War.

They made an estimate of $11,514,200 for a canal. They reported against the "stirring process" then in use by the Government.

They reported in favor of the jetty plan, and selected South pass in preference to one of the other larger passes, believing that although its width was only 700 feet, as against the 1,400 feet of Southwest pass, it would be adequate for the present and prospective wants of commerce, contemplating a depth of 25 feet as a minimum to be maintained. The estimates for construction and maintenance were $7,942,110 for South pass and $16,053,124 for Southwest pass.

The report was signed by all the members of the board, except one, who thought the chances of success did not justify the recommendations of the board.

Soon after the submission of the report, Mr. Eads made a new proposition to Congress to make a channel 30 feet deep at the mouth of Southwest pass and maintain it for twenty years.

He had previously urged upon the board forcibly and eloquently to report in favor of Southwest pass. The words used are too important at this juncture to be kept back.

"It is rarely that gentlemen of our profession have such an opportunity of indelibly recording their judgment. I earnestly trust that you will, on this occasion, unanimously recommend the improvement of the Southwest pass, and thus leave, as an imperishable evidence of your foresight and public spirit, such a deep and broad channel at the mouth of the grandest physical feature of this continent, as shall win for you the thanks and praise of the hundreds of millions which the Mississippi valley will hereafter contain, and whose grand commerce must naturally and forever seek that route to the sea."

Briefly, the objections of Mr. Eads to the South pass were (and his predictions have been fulfilled), first, that the extensive shoal in the head of South pass would be difficult of removal and the channel through it difficult of navigation, and, second, that the channel through the twelve miles of the pass was too small for easy navigation and inadequate to the growing wants of commerce.

Regardless of the recommendations of the board in favor of South pass, the House of Representatives, upon the unanimous recommendations of the Committee on Commerce, passed the bill in favor of Southwest pass, with only two dissenting votes; but on reaching the Senate it was amended to apply to the small pass, the reason being that, having obtained the advice of a board of army engineers, who had reported in favor of the Fort St. Philip canal, and then of a subsequent board who had recommended jetties at the little pass, it would, in case Mr. Eads did not accomplish what he contracted to do at Southwest pass, have no defense for having refused the advice of its own experts; no doubt the greater cost had something to do with the decision.

The Senate committee were immovable, and Mr. Eads was informed that if he would give the same guarantees and agree to produce the same depth in the little pass, and build the works for $5,250,000 and maintain them for 20 years for $100,000 per annum, the improvement would be placed in his hands, otherwise not. The bill thus amended was passed, all of the discussion and action taking place in considerable haste in the last hours of that Congress, the concurrence of the House being secured just before final adjournment, on March 3, 1875.

The dimensions of channel as to width proposed for the much larger Southwest pass, four times as large in volume, remained in the bill, and a full discussion and study of the complicated questions at the head of the passes, or through the pass, found no time in the haste due to the closing of the session.

The maximum dimensions between the jetties, from the deep water of the pass to the deep water of the gulf, were 30 feet deep and 350 feet in width at that depth, and the dimensions through the pass and the shoal at its head were simply a navigable depth of 26 feet.

In order to definitely interpret this and some other features of the contract, Secretary of War Cameron, on November 2, 1876, referred some questions to a board of three United States engineers entirely familiar with the matter. The second question was,

"Query 2.—What depth and width of channel is it desirable to secure permanently through this shoal?"

The answer was:

"The second proviso to section 4 of the act demands a navigable depth 'through said pass,' and, of course, through this shoal, of 'twenty feet' within thirty months, and 'an additional depth of not less than two feet during each succeeding year thereafter, until twenty-six feet shall have been secured.' We deem these depths to be satisfactory, and, considering that an inland channel requires less depth for equal facility of navigation than a sea exposed bar, that they are fairly equivalent to the greater depths demanded by the act in its fifth section for the 'wide and deep channel connecting the pass with the Gulf of Mexico.' "

It being evident that the dimensions between the jetties above stated were not adapted to the size of the small pass, Congress passed an amendatory act, March 3, 1879, reducing the maximum dimensions of the channels so as to read "26 feet in depth and not less than 200 feet in width at the bottom," and "30 feet in depth without regard to width." The depth of 26 feet in the head of the pass and in the pass itself and the above dimensions in the jettied channel have been the legal requirements by the War Department upon Mr. Eads and his executors from that date to the present time.

Another question submitted by the Secretary of War in 1877 to a board of United States engineers related to dredging. The board reported that it was a proper method as an auxiliary and referred to the report of Humphreys and Abbott and to that of the board of 1874, in both of which dredging was recommended as a necessary accessory to jetties. They state that the act under which the jetties were constructed clearly intends that jetties and auxiliary works shall be the effectual agents, but allows of dredging as auxiliary, and they refer to the procurement of a wide and deep channel as so exclusively due to the "jetties and auxiliary works that the aid of appliances, if in such dredging is included, was utterly insignificant."

Taking the whole volume of bar removal into consideration, some millions of cubic yards, a large estimate of the dredging would be 1 per cent of the whole.

The requirement of the act that three dimensions of the channel through the jetties should be maintained has made a resort to dredging imperative, and the very fact that controlled natural forces accomplished the formation of the channel makes it evident that artificial dimensions of a congressional enactment are difficult of maintenance by natural agencies. It has been found often difficult to keep the channel the full legal width when the river seemed to have its own reasons for making a much deeper channel than 30 feet, or to maintain a full 30-foot depth in the center when the river was endeavoring to make a 26-foot channel much wider than the legal requirements.

Most of the dredging done in the last seventeen years was for the purpose of rectifying the form rather than the size of the channel, and at all times this channel through the jetties has been equal to navigation requirements.

It is now necessary to state and discuss some important physical conditions at the head of the passes.

An examination of the charts will show the complications existing there, and which Mr. Eads fully appreciated and wished to avoid by the selection of the larger pass.

It can be stated advisedly that the problem presented there for solution was one of the most difficult, perhaps superlatively so, of any ever dealt with successfully. The problem at the mouth of the pass was very simple in comparison. "To get the water out through one deep channel was a far more simple process than to get it into a small pass, through a narrow, artificially contracted channel, located immediately between two great natural outlets."

There were many occult conditions, many sensitive but potent forces. There was an equilibrium of all of them that would, when disturbed, work great changes quickly and sometimes disastrously. The bed of the river is almost as easily moved as though formed of a semi-fluid mass. The sediment at high water, moving steadily seaward in solution, takes the first opportunity to drop to the bottom after its long journey from the mountains and plains. The engineer can never know what will result from handling such sensitive conditions, and yet so mighty—possibly a million cubic feet of water, loaded with sediment to its full capacity, passing in a second of time.

The problem was further made extremely difficult by the great depth and volumes of the adjacent passes, into which from the main river there was generally about thirty feet depth, whereas into South pass there was only fifteen. While the expression may not be literally true, it was almost like making the water run up hill to force a channel through the obstructing bar with such easy pathways alongside of it down hill.

An examination of the location of the works at the head of the passes shows that a contraction of the passageway into the South pass, and so a concentration of the entering volume, and the raising of the surface of the water above in order to get more fall and consequently more than the normal velocity, thus producing scouring or deepening, was the principle employed. It will be readily understood that the greater fall thus made into South pass inlet would also make a greater than the normal fall into the two great adjacent passes, and as a result a scouring of their beds also, and, further, that, as there exists no obtruding or resisting bar in their channels, it would need a less slope of water surface to send the water down these deep passes than into the choked-up head of the South pass.

This is what really happened and had to be met by preventing the enlargement of the sections of the deep passes by means of mattress sills built of brush laid as a carpeting entirely across them from their banks to the works in the head of the South pass.

The entire river had to be bridled in order to compel it to follow the directions of the engineer.

CAUSE OF THE DETERIORATION OF SOUTH PASS

The pass-a-Loutre crevasse in the pass of that name, one mile and a half below the head of South pass, occurred in January, 1891. The fall or surface slope through it at flood time was very steep, about 2½ feet within a short distance. This had a very deleterious effect upon the South pass channel.

It increased the volume of pass-a-Loutre from 45 per cent of the whole river to 51 per cent, and decreased the volume of South pass from about 10.5 per cent and 11 per cent to about 7 per cent; that is, it reduced its volume about one-third.

It will readily be seen that this should be the result, for the slope into pass-a-Loutre from the main river has been steepened by this crevasse from about the normal 2 inches per mile to 6 inches per mile. There must necessarily be a side flow from the head of South pass down this slope, as the neutral point, where the river water separates to flow into the respective passes, is above the works built in the head of South pass.

Now, what would naturally be the result of these new conditions? To answer this the sedimentary conditions must be known and their effects understood.

It is well known that alluvial streams quickly adapt themselves to their requirements. If the volume, by changes of other conditions, is increased, the size of the pass, its depth and width, is increased; the stream not only bears forward, and can easily do so, the weight of sediment that is brought to it, but, in addition, it picks up from its own bed the alluvion through which it flows and carries that forward also, until, by such scouring and deepening and enlarging action, it has restored the equilibrium between the slope of water surface, volume and size of channel, and then the scouring ceases. Exactly the reverse happens when the volume for any reason is reduced below the requirements of the channel; the current is slackened, its force weakened, and it can no longer carry forward all of its load of sediment, and it drops some of it in the channel. This process continues at each high water, when the water is charged with sediment, until at last it has reduced the size of its channel to conform to its volume and other requirements.

This action of shoaling and diminution of channel dimensions is just what we find to have taken place in the South pass and at the head of the pass. This process has continued for just six years. At least, this is the most potent factor in the changes so injurious to navigation that have taken place throughout the whole length of the pass, although it should be stated that the idea even of attempting to make and maintain a channel through the head of South pass was, as is now seen, ill-advised, and should never have been attempted, and probably would never have been carried out had Congress been able at the time to give more thought and study to the question.

It may possibly be said that the jetties, two and one-quarter miles in length, at the mouth of the pass, have lengthened the total fall of the water surface between the fixed point at the head of the passes and the fixed plane of the Gulf of Mexico, and have, therefore, reduced the slope per unit of length through the entire pass, and, consequently, its velocity at high water and its silt-carrying power and its requirement for as large a channel as it had at the outset before improvement. The above statement is in error simply because one important physical condition formerly existing has not been taken into account. The correct conditions are stated in the following quotation from a writer on this subject:

"It has been stated that the slope of the water surface at flood river is flattened by extending jetties from the land into the sea; this is not the case. The sea bar before improvement is a submerged dam, and its effect, like any other dam, is to raise the water above it and flatten the river slope above it. Cutting it away and substituting a deep channel, with less resistance to the flow, steepens the river's slope back of the bar, and makes the conditions normal, producing a straight, even slope where there was a broken one for some distance above the jetties. There is no doubt that this happened at the mouth of South pass."

The bed of the South pass has been filled up partly by an immense deposit of sediment, due largely to the depletion of its volume by the crevasse. The shoaling causes the bed to rise higher and higher, and has reached the danger limit! Hereafter there may be expected, during river conditions that may occur at any time in the periodic floods, deposits of sediment in the pass, or the formation of shoals and bars above the pass to such an extent as to be seriously damaging to navigation, and possibly prohibitive of it by deep draught vessels.

While this may not certainly happen this year or next year, it is only a question of a brief period when inevitably the conditions will operate as predicted.*

The value to the Mississippi valley and these entire United States of the open river mouth to the sea can scarcely be overestimated; even a conservative estimate might, without absolute proof, be considered extravagant.

To ascertain the money value of this channel during the last two decades, since the first ocean steamship passed through it, involves many complicated conditions difficult to analyze and place together for summation, but it is important to make some attempt at the calculation, in order to show and prove that it is of great importance to the entire country and the world over to maintain a channel at the mouth of the Mississippi adequate for the largest and deepest class of ocean vessels.

The conditions prior to the opening of the channel have been sufficiently stated in the historical résumé of the subject to give an idea of the serious obstacles to commerce. The maximum channel required by the contract with the Government was obtained in the summer of 1879, although ocean-going craft had begun to use it in 1876 and 1877.

By 1880 a marked increase in commerce and a notable reduction in ocean rates had occurred, and also in transportation rates from the Mississippi to the Atlantic seaboard. The shallow depth over the bar had previously prevented vessels drawing over 18 feet from coming to New Orleans. Those that did come demanded and received high rates of freight—⅝d per pound—1¼ cents. Rates almost immediately went down to ⅜d—¾ of a cent, both cotton and grain freights rapidly increasing in tonnage.

An estimate was made that the reduction in rates even at the beginning of operation of the channel effected a saving in one year of over $4,000,000, in addition to the saving in insurance and in time by freedom from any detention on the bar. Five million dollars was conservatively estimated at that time as the annual saving to the producers of the Mississippi valley on productions finding a market through New Orleans.

An important incidental benefit to the commerce of all commercial nations resulted from the following peculiar conditions: Before 1875 New Orleans, although practically shut out from the deep-draught commerce of the world, was a favorite cotton port. The season was short, but the business was good, the rates of freight high, and the vessels of many nations came there during the cotton season regularly, and the profit of coming was so great even for one trip that vessels were built for this port, although trading the rest of the year where they found much deeper water. But with the advent of deep water at the mouth of the Mississippi this condition was radically changed; everywhere it became known about the world that the port of New Orleans was opened to deep-draught vessels, and at once there began the construction of deeper vessels and of much greater tonnage to take advantage of these improved conditions. It is, therefore, not too much to say that the opening of this great cotton and grain port to

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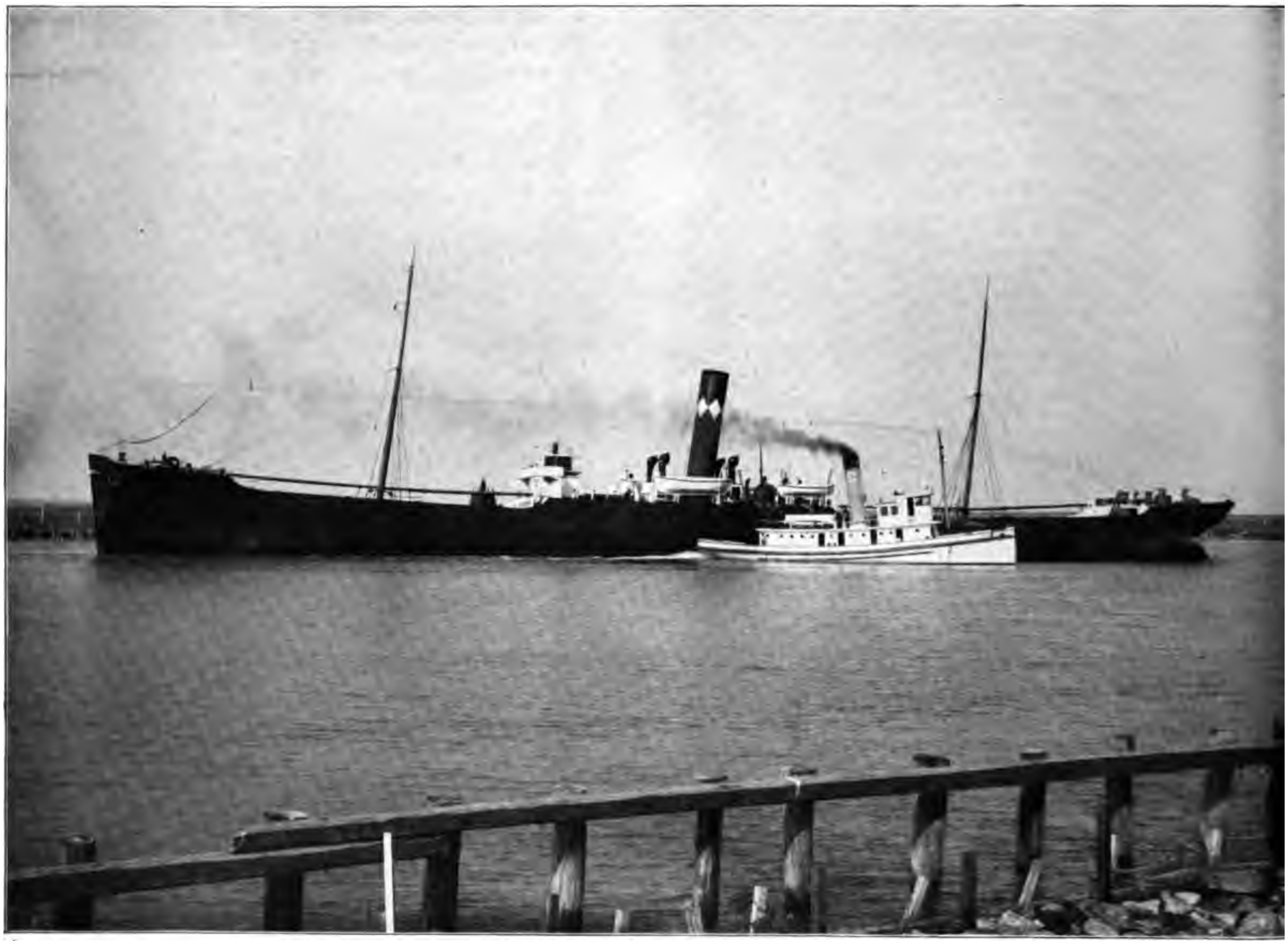
* **For a remarkable confirmation of this prediction see next page.**



SHIP AGROUND IN SOUTH PASS

deep-draught vessels brought about as much as any other cause the era of great ships. Shall the port that worked such a beneficent revolution in the world's commerce be allowed to degenerate into a fourth-rate port, sealed up against the very ships which it has caused to be built?

Knowing the rapidity with which the news of the great success at the mouth of the Mississippi passed from port to port and country to country, and, subsequently, of the inauguration by the efforts of the same engineer of the Mississippi river improvement, is it surprising that the first American to receive the Albert medal by the Society of Arts of Great Britain should be James Buchanan Eads "for improving the water communications of North America"?

It is now necessary to trace some still more important developments than those recorded in 1880. The last sixteen years have recorded benefits properly attributable to this port, with which the entire country is concerned and will appreciate when stated.

Referring to tonnage of vessels again, there has been a steady advance yearly since 1876. In that year the average tonnage of all vessels entering the port was 732. In 1882, when the new and larger traffic had got fairly under way, 1,039 tons; in 1891, 1,257 tons; in 1896, 1,511 tons, an increase over 1876 of about 100 per cent. Briefly summarizing other commercial changes, the draught of vessels has increased from 17½ feet to over 26 feet, and steamships have largely displaced sailing vessels.

New Orleans trades with nearly every port of the world. In 1895 it traded with 29 countries, and last year there were vessels there from 178 ports.

The larger proportion of steamships now belong to regular lines, not "tramps," as formerly. Twenty-five regular lines, many of them running a large number of steamships, do a regular business at this port, sailing at regular intervals and at stated times.

In 1870 there were only four regular foreign lines. Examining the list of steamers belonging to regular lines, there will be found many of 4,000 tons and upwards, there being now thirteen of over this tonnage; there are two of over 5,000 and under 6,000 tons, and two of over 8,000 tons, and there are ten of over 4,000 tons not belonging to regular lines, but which do a regular business at New Orleans.

The two steamships above mentioned are 8,195.66 tons gross; displacement, 16,070 tons; dead weight capacity, 11,150 tons; cubic capacity, freight tons, 14,800, of 40 cubic feet, deepest draught, loaded, 28.6 feet mean, or 30 feet by the stern, requiring a 31-foot depth of channel. These vessels are 485 feet over all and 55 feet breadth; they are 39 feet 6½ inches in depth. They cannot load, however, to more than three-quarters of their capacity, as the channel to the sea is not of sufficient depth. They belong to the West India and Pacific Steamship Company. These details are given to show that steamships regularly trading at this port require a larger and deeper channel than now exists through the South pass. Already New Orleans is discriminated against in comparison with other ports of deeper draught, and it becomes more and more evident that, if she is to hold her commerce, there must in the near future be provided a larger channel to the sea than 26 feet.

It is unnecessary to remind Congress that it has itself inaugurated, under the strenuous demands of various ports of the first class, such as New Orleans is, a depth of 30 feet.

In the last River and Harbor act, of June 3, 1896, the channel depth in the harbor of Baltimore, Md., is to be deepened to 30 feet, and under examinations to be made by the Secretary of War are found the following items:

28 feet depth of channel at Annapolis, Md.; 30 feet deep and 600 feet wide at Philadelphia; 30 feet deep and 1,200 feet wide at Boston; 35 feet deep at New York, from the Narrows to the sea; 30 feet deep and 1,200 feet wide in New York harbor, between the Battery and Governor's Island.

Existing projects contemplate 30 feet at Galveston; the same depth has been obtained at the mouth of the Columbia river, Oregon; and it may be incidentally remarked that this depth of channel at low water has been obtained at Liverpool, England, where there was formerly only 11 feet, particularly in order to admit American commerce without detention by waiting for tide.

The vast benefits of the Mississippi open river mouth is not alone to the ocean commerce. The changed conditions that brought that commerce have also brought a great railroad commerce.

As late as 1880 there were only two main lines into New Orleans. There are now six. Formerly the Illinois Central to Chicago, but broken by the Ohio river at Cairo, and the New Orleans and Mobile, since merged into the Louisville and Nashville system. The Southern Pacific was not opened through until 1883. The New Orleans and Northeastern (Queen and Crescent) was built later than 1880, and the Yazoo and Mississippi Valley, from New Orleans to Memphis, now merged into the Illinois Central system. The Texas and Pacific has been built, reaching to many Texas points, and there are two local roads extending some distance down the river on each side; and the New Orleans and Western, a belt railroad in the rear of the city, with its terminal at Chalmette, below the city, where it has extensive facilities for handling cotton and grain.

There are few, if any, ports of the world that have railway systems directly tributary to them as comprehensive and far-reaching as those which terminate in the city of New Orleans.

In 1876 the total rail commerce was 731,514 tons; in 1892, 3,980,996 tons; in 1894, 4,014,072 tons, an increase of 463 per cent over 1876. The total number of loaded cars increased from 151,332 in 1880 to 517,555 in 1892, 222 per cent, the latter averaging much larger and with much greater loads.

Comparing the total commerce at New Orleans, ocean, rail, and river, there were in 1876, 5,427,827 tons, and in 1895, 10,397,493 tons, nearly 100 per cent increase. From the annual and quite regular increase of all the traffic it is reasonable to expect by the end of 1899 nearly 12,000,000 tons.

All, or nearly all, this immense increase in commerce is properly attributable to the jetties. One of the most important commercial developments at New Orleans has been the Southern Pacific and Morgan steamship coastwise business between the Pacific coast and New York.

This route was opened for business in 1883; previous to that it had run comparatively small steamers of about 1,800 tons to New York; now there are ten from 3,000 to 4,664 tons—a total, with the Texas and Cuban lines, of about 50,000 tons. The great value of ocean transportation in competition with rail is seen in the ability of this Morgan Line steamship route to compete with all rail across the country. It is a half water route between the two coasts of the United States. The same interest not only controls, but operates the rail and water route from San Francisco to New York. Previously the overland rail route had handled the through traffic between the Atlantic seaboard and San Francisco, to the great dissatisfaction of shippers and merchants in San Francisco. The time of transit was about sixty-five days and it was exceedingly uncertain of date of arrival, so that the merchants were placed at a great disadvantage, being unable to make arrangements for their business or to give their orders with any expectation of a definite arrival of the goods. The Southern Pacific undertook at the outset to do this business regularly and with dispatch, agreeing not to have the goods en route over twenty-five days. It fulfilled its engagements, met all losses promptly that occurred by wrecks or other casualties, and it has reduced the time since then to about sixteen days.

This improvement in method and time compelled the eastern connection of the Central Pacific and other transcontinental lines to change entirely their traffic methods in order to meet the competition of this New Orleans route, until they also, by better management and less delay at terminal points and yards, reduced their time to twenty-five days, and have been able to maintain it until the present time.

The tonnage moved between Pacific coast points (Arizona and New Mexico excepted) and New York via New Orleans, in connection with the Morgan Line of steamers, has increased from 36,000 tons in 1883, when the route was opened, to about 215,000 tons in 1896.

It will be seen from this illustration of the developments at the port of New Orleans how far-reaching has been the benefits of the Mississippi jetties. It would be difficult to estimate the money value of these great advantages to the Pacific coast, but it is very large.

Discussing now the actual commercial advantages that have accrued to the Mississippi valley region and the country at large, some important statements in the way of comparisons need to be made.

It was expected in 1879 that the Mississippi river would, within a reasonable time, be improved by the Government between New Orleans and St. Louis, so that a deep draught barge navigation could be employed to bring at minimum cost the products of the Mississippi valley to ship side at the port of New Orleans.

The Government has thus far failed to accomplish this, and as a result of this and the active railroad competition the river traffic has decreased, particularly above the delta country. In 1876 the freight tons arriving and departing by river were 3,313,014; in 1892, 1,934,925, the respective values being $173,826,434 and $72,760,956, a decrease of 41½ per cent in tonnage and 59 per cent in value. The river traffic conditions since 1892, due to continued low water and inadequate depth for navigation in some years, are not improving, to say the least. Notwithstanding this unfortunate situation, the river has been able, through the entire period of twenty years, to assert its ability to regulate, or at least affect, rates and to hold them down on railroad traffic wherever the latter comes to the river or moves along its banks. It is unnecessary to state in detail the well-established results of competition in lowering rates under such conditions. The water compels the railroad near it to reduce its charges; this compels other railroads in the same territory to do the same, even lines intersecting are affected, local rates are reduced as well, the effect extends finally to remote lines and districts until the entire country is more or less benefited. The claim made for the Mississippi jetties, that they have made living cheaper to the entire Atlantic seaboard, as well as to the Mississippi valley and the great interior country, is well founded.

This competitive condition of rail with river and North and South lines of rail with each other, and particularly with East and West lines to the Atlantic seaboard, has led to the development of an immense traffic at low rates throughout the entire Mississippi valley. The railroads have not only appreciated the great advantages of this port, with its deep entrance for vessels of large tonnage, but have gone to work to take advantage of it, as has been shown above. There has, therefore, been established what may generally be called the "Mississippi valley route," by water and rail, in place of the former "Mississippi river route," by water only.

The area is wider still, if we consider the far-reaching points of the railroads directly tributary to the port, extending much beyond the drainage area of the Mississippi and its tributaries. Approximately, therefore, we may say, to convey some idea of the tributary commerce of New Orleans, there are 16,000 miles of navigable river and 16,000 miles of rail, reaching all over Texas and to States eastward, some of the waters of which empty into the gulf elsewhere. Therefore, we should call it the "New Orleans route."

It is this great comprehensive system of rail commerce that makes it of vastly greater importance than formerly to the whole country to maintain an adequate entrance to the port of New Orleans for the largest and deepest class of ocean vessels.

"Importance to the whole country" are words used advisedly, as will be shown by some figures given further on to show the value of the New Orleans route as a competitor with routes extending from the Mississippi valley to the Atlantic seaboard and to Europe, and from the interior of the southwest and west to other points on the Gulf of Mexico.

At this very time the Illinois Central Railroad is exerting marked influence upon rates by bringing to New Orleans for European shipment an immense tonnage of cotton and grain, which it is shipping through its extensive facilities at that city.

In a recent paper before the American Association for the Advancement of Science, in "Some notes upon the Delta of the Mississippi," I used the following words applicable to the present question:

"Great terminals are now being completed at New Orleans to accommodate the immense business coming there for shipment to Europe and the Atlantic seaboard cities from the great valley of the Mississippi directly tributary to this port.

"The commercial advantages of the improvements at the mouth of the Mississippi have brought to New Orleans a commerce far beyond the expectations of even its most sanguine advocates, and this commerce, in size of vessels, in magnitude, and in its value to the country and the world, has by no means reached its limit, but is still expanding and assuming greater and greater proportions and importance.

"The commerce demands, however, the very largest steamships to take the greatest advantage of all the favorable conditions. Were an adequate, permanent, constant channel for such vessels to the sea assured, there would be no question of the early construction of 10,000-ton freight carriers to run between New Orleans and western Europe.

"Opening a competitive route to all rail from the interior to the Atlantic seaboard by way of the jetties has affected commerce, and through it this entire country, and Europe as well, for it has reduced rates from the Mississippi valley and the west and the Pacific to the Atlantic seaboard and Europe. It is not too much to say that it has made bread cheaper to those great populations that require the food products of the great central zone of our country and of the Pacific slope."

An attempt will now be made to ascertain, approximately, the money value to the people of the United States of a deep entrance to the port of New Orleans during the last two decades, covering the period of influence of the jetties.

It is necessary to go into some details of changes in freight rates:

Fall and winter rates on cotton from New Orleans to

LIVERPOOL AND HAVRE

	Per Pound.
1872-'75	1.34 cents
1876-'80	.91 cent
1881-'85	.74 cent
1886-'90	.68 cent
1891-'95	.47 cent
1896-'97	.44 cent

TO NEW YORK

1872-'75	.78 cent
1876-'80	.58 cent
1881-'85	.37 cent
1886-'90	.43 cent
1891-'95	.34 cent
1896-'97	.30 cent

All rail grain rates from East St. Louis to New York: 1877, 41 cents per 100 pounds; 1895, 23.57 cents.

To New Orleans: 1895, 20 cents.

Cotton rate to New York: 1895, 30 cents per 100 pounds, which is the same as the water rate from New Orleans, the competition affecting it.

River rate from St. Louis to New Orleans on grain in sacks, by steamboat, 20 cents per 100 pounds, which is about the same as in 1880. During various years between these dates it has gone down to 15 cents and 16 cents, and as low as 14 cents in 1884. The wheat rates in bulk by barges have ruled at about 10 cents per 100 pounds during the entire period.

Rates per bushel on export wheat from St. Louis to Liverpool, via New Orleans, by river, and via New York, by rail: 1883, via New Orleans, 20c, via New York 27c; 1895, via New Orleans 12½c, via New York, 18.33c; the present via New York, from St. Louis, rate being about 50 per cent higher than via New Orleans.

As to the volume of traffic. Bulk grain exported from New Orleans in 1895, 9,644,377 bushels; received at New Orleans by river from St. Louis, 1,690,417 bushels. The difference of 7,953,960 represents mostly rail traffic to New Orleans from Mississippi valley States.

Rates on the railroads have been as follows:

Illinois Central, southern rate per ton per mile: 1876, 1.72c; 1886, .68c; 1896, .64c.

Reduction in rates per ton per mile (dates earlier than 1883 not accessible):

	1883.	1895.	Reduction.
(1) Gulf and Mississippi valley States	1.66c	.89c	.77c
(2) Southwestern States	1.88c	1.24c	.64c
(3) Central northern States	1.04c	.71c	.33c
(4) Middle States	1.04c	.74c	.30c
(5) Entire U. S.	1.224c	.839c	.385c

The total ton miles in 1895 in these groups of States and the United States were as follows:

(1)	38,000,000,000
(2)	71,000,000,000
(3)	316,000,000,000
(4)	296,000,000,000
(5)	890,000,000,000

Assuming that the advantages and competition of the Mississippi jetties reduced the cost per ton mile 3-10c in group one, 2-10c in group two, 1-10c in group three, and 5-100c in group four, and, adding to the above totals of traffic the approximate ton mileage for 1880-1882, and for 1896, we have for an estimate of reduction in cost of transportation by rail, caused by the jetties, $394,000,000; or, per annum for the seventeen years, about $23,000,000. As the reduction in rates has been progressive, the reductions above stated have been divided by two for convenience of calculation to obtain a fair average.

The receipts and shipments by ocean at New Orleans amount to a total of 44,000,000 tons since 1880 (the amount in the previous decade not being accessible). The reduction on rates on cotton and grain shipments since 1875 average about $10 per ton to Liverpool, Havre, Bremen, and New York. Assuming that one-half of this reduction is attributable to the jetties, and applying one-quarter of it to the entire tonnage, there results $110,000,000, or $6,470,000 per annum of saving from this port alone.

It is difficult to estimate the reduction in rates from all Atlantic and gulf ports caused by the Mississippi jetties, but it amounts to something.

From 1876 to 1895, inclusive, there were exported 1,300,000,000 bushels of corn, equal to 36,400,000 tons; 1,400,000,000 bushels of wheat, equal to 42,000,000, tons, making a total of 78,400,000 tons of grain, and about 22,000,000 tons of cotton; a total of the above three articles of export of, say, 100,000,000 tons.

The reduction in rates at New Orleans has made some reduction on this large export business, and there might reasonably be applied to 89,000,000 tons (having deducted the New Orleans tonnage), $1 per ton—$89,000,000, or, say, $4,400,000 per annum during the twenty years.

There are many other export articles to which this calculation might properly be applied, and there has been no account taken of any imports or receipts by coastwise business, except at New Orleans. These would swell the total to much larger figures.

Summing up the annual saving, above stated, we have the following as the approximate money value annually to the country from the Mississippi jetties:

By reduction in cost of transportation by rail	$23,000,000
By reduction in ocean rates, New Orleans business	6,470,000
By reduction in ocean rates, other United States ports	4,400,000
	$33,870,000

There are, however, some elements to be considered on the other side of this question. The prices and rates by ocean and rail in 1876 to 1880 were inflated on account of the currency inflation.

The compressing of cotton for export, which began about 1889, reducing the size of bales at least two-thirds of the "flat" bulk, tended to make lower rates of ship freight. The cost of compressing being put upon the shippers also tended to reduce rates.

The improvement of other harbors along the Atlantic and gulf coast may have exerted a greater influence upon rates than we attributed to them. Possibly the general tendency all over the world to lessen the cost of transportation on land and water, rail and steamship, may not have been fully credited with its effect.

The influence of the Erie canal and the great lakes route in reducing or affecting rail rates may also have exerted a greater effect upon the Northern, Central, and Middle States groups of railroads than we have taken into consideration, and there may be other potent influences at work not considered.

Allowing to all these factors a generous amount of influence, we reduce the figures to $25,000,000 as the annual money value of the Mississippi jetties to the people of this country, with the belief that more extended calculations and considerations would greatly swell this estimate.

THE MISSISSIPPI RIVER COMMISSION

Incidents Leading Up to the Formation of this Important Commission, Etc.

"In considering the Mississippi river, we must regard it as a river of sand as well as of water." In the foregoing sentence, Hon. Randall Lee Gibson, United States Senator from Louisiana, pithily stated the problem which it has been the endeavor of civil and military engineers to solve for three-quarters of a century. This problem presents phenomena seemingly discordant and irreconcilable, and yet known to be controlled by and obedient to fixed laws. To obtain accurate knowledge of these laws was the first essential step toward the perfection of a plan that should overcome all difficulties and keep this mighty stream under human control.

The first official action by the general government in this direction was taken in 1822, when two engineer officers of the army, General S. Bernard and J. G. Totten, after a careful study of the river, made an elaborate report (December 22, 1822) in which they set forth the result of their investigations, and declared: "The only means which appear practicable to us is the construction of dikes. They operate by diminishing the current above them, thus economizing the expanse of water, at the same time constraining the current to rush with greater velocity through the narrow space to be deepened."

In the same report they describe the effects of the floods they had witnessed, saying: "While the waters of this river are over its banks, the operation of the current being in proportion to its elevation and consequent increase of velocity, the changes which are produced in the bed of the river are great, sudden and numerous. Then are produced those multiplied turns and elbows which so strikingly characterize this great river, and which increase its channel to the double what it would have been if the banks could have resisted its current. The corresponding concave parts of these turns are sometimes separated only by a very narrow neck, which being cut through by the waters, as often happens, present a new and navigable channel of perhaps a half mile in length, in lieu of the old one of 15 or 20 miles. The abandoned channel is entirely divided from the river except in floods, and on the west side, especially, becomes a lake."

The floods of the Mississippi are one of the phenomena to be understood that they may be regulated. The other is the low-water periods. "At certain seasons of the year," said Senator Gibson, in one of his instructive speeches, "the water subsides, the channel is blocked by snags and sandbars, and for a great distance there is only from four to eight and a-half feet depth. This condition continues not for a few days or a few weeks, but for several months during every year, interrupting trade and commerce, and making its navigation difficult and perilous; the largest and costliest boats, in which great sums are invested, and that give employment to thousands of people, are compelled to lie idle; the navigation of the river is almost as effectually closed as if artificial dams were built across its bed."

While the report made in 1822 by army engineers awakened much interest in the improvement in the Mississippi, and was probably the primary movement which ultimately led to the large grant of public lands made in 1840, yet there was not at that time any popular comprehension of the importance of the work needed, or of the vast national interests that would be served if it were undertaken and accomplished. In 1845, two distinguished Congressmen, James Gadsen and James Guthrie, acting as a sub-committee, made as thorough an examination of the subject as was possible, and prepared a report upon the navigation of the Mississippi, which was approved by Hon. John C. Calhoun, who submitted it to Congress. In that report the situation was carefully stated, and it was said:

"The expenditures on the Mississippi thus far, if reports are to be credited, have produced no results corresponding to the vast sums appropriated. When the channel has been straightened at one point it has been lengthened at another, and obstructions or deposits in one bend have only been

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THE MISSISSIPPI RIVER COMMISSION

transferred in their removal to another. 'Sawyers' and 'planters' have in one season been reduced in number to be replaced by the succeeding one.

"The only fact clearly established, and it is one to which attention should be particularly directed as bearing with peculiar influence on the proposition submitted, is that where the banks of the Mississippi have been leveed and prevented from inundating the swamps, the spring rises are scarcely perceptible, and the surplus waters are discharged by deepening the bed; its currents no longer able to rise and expand over a wider surface, they have to deepen the bed to furnish vent for the waters to be discharged. The reclaiming, therefore, the swamps and confining the river to its bed will deepen it, and do more to preserve unimpaired the navigation of the Mississippi than all the projects which have hitherto been devised or acted on for its improvement. The suggestion, however, is worthy of examination, and it is the stronger recommended as it may accomplish a great object at comparatively little cost. The swamps of the Mississippi now worthless, and made so by the inundations of that river, may be made, by their own reclamation, the instruments of improving the navigation of that stream."

In this declaration is shown the fact that although the work of the preceding years had been so disconnected that what was done at one point had destroyed the work at some other, still the theory advanced by Engineers Bernard and Totten seems to have been proved correct.

At great cost the country was gradually acquiring knowledge as to how to deal with this "river of sand as well as of water." It was also slowly, very slowly indeed, beginning to learn that the great waterway that extended from Canada to the Gulf was a national stream, beyond the power of the interior States to improve and to control. In his last speech in Congress Henry Clay, the greatest of the distinguished galaxy of statesmen that adorned that era, referred to this public ignorance, or narrowness of view, with a pathos all the more impressive, because of his broad national ideas and his prolonged and eminent services to his country. The bill making appropriations for river and harbor improvements being before the Senate, Mr. Clay, after some preliminary remarks, said:

"An honorable senator has gotten up and told us that here is an appropriation of $2,300,000. With regard to the appropriations made for that portion of the country from which I come, the great valley of the Mississippi, I will say that we are a persevering people, a feeling people and a contrasting people; and how long will it be before the people of this vast valley will rise en masse and tumble down your little hair-splitting distinctions about what is national, and demand what is just and fair on the part of this government in relation to their great interests? The Mississippi, with all its tributaries, constitute a part of a great system, and if the system be not national I should like to know one that is national. We are told that a little work, great in its value, one for which I shall vote with great pleasure—the breakwater in the little State of Delaware —is a great national work, while a work which has for its object the improvement of that vast system of rivers which constitute the valley of the Mississippi, which is to save millions and millions of property and many human lives, is not a work to be done because not national!

Around the region of the coast of the Atlantic, the Mexican Gulf and the Pacific coast everywhere we pour out in boundless and unmeasured streams the treasure of the United States, but none to the interior of the West, the valley of the Mississippi. Every cent is contested and denied for that object.

Sir, I call upon the Northwestern Senators, upon Western Senators, upon Eastern Senators, upon Senators from all quarters of the Union, to recollect that we are part of our common country."

Had the facilities for the transmission of congressional proceedings been then what they are now, this address would have appeared in full in every morning paper in the land, and this appeal would have been responded to by the devoted friends of Henry Clay in every State. But it was heard only by his audience in the Senate chamber, and was then buried in the pages of the Congressional Record. It had its effect, however, upon pending legislation, for an appropriation for work on the Mississippi was made.

In 1850 Colonel Humphrey and Captain Abbot, of the United States Engineers, were detailed to make a complete survey of the Mississippi. They spent ten years in the work. Their report has been pronounced "a monument of industry and learning." It convinced many, in and out of Congress, that some continuous system ought to be adopted for insuring the commerce of the river against the losses consequent upon floods and low water pe-

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COL. O. H. ERNST
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THE LATE GEN. QUINCY A. GILLMORE
Corps of Engineers, U. S. A.
First President of the Commission

THE LATE JAMES B. EADS, C. E.

THE LATE HENRY FLAD, C. E.

RMER MEMBERS OF THE MISSISSIPPI RIVER COMMISSION

GEN. C. B. COMSTOCK
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riods. The general opinion seems to have been that more levees should be built, and that those already constructed should be strengthened where necessary. Special committees were created by Congress, who agreed upon a bill for constructing levees, which passed one house only to be lost in the other. Meanwhile, the people of the Mississippi delta were steadily taxing themselves to maintain the existing barriers, which were essential to their protection. Then came the war, with its attendant devastation. During its continuance the levees were neglected, and many were either in part or wholly destroyed. Soon after peace was declared, in 1865, Secretary Stanton ordered the levees to be rebuilt, believing, says Senator Gibson, that it was an "act of humanity to restore these public works essential to the good order of society, and now needed more than ever by a people struggling with poverty amid social and political conditions involving a disruption of traditions and customs and established relations, but it was not done."

In 1871 a commission was again appointed to determine what ought to be done. President Grant was strongly in favor of its recommendations to reconstruct the levees, but even his influence was not sufficiently powerful to produce favorable action in Congress.

Meanwhile a new interest in the condition and needs of the lower Mississippi valley had been created that was to have a most potential influence upon its future. Population had followed the lines of the trans-continental railroads and their feeders until great States had been carved out of the country on both sides of the Rocky mountains; prosperous cities had sprung into existence; vast areas of wilderness had been brought under cultivation, and for their immense crops of wheat and corn there was no adequate transportation. From all these fertile farms and prosperous cities came a demand for the improvement of the Mississippi. The plan of a voluntary association was suggested. St. Louis took the lead in this matter, and soon a powerful organization was effected, numbering in its membership many influential citizens of every State from Minnesota to Louisiana, and conventions were held, statistics were compiled, public spirit was aroused, and the public opinion of the entire region from Canada to the gulf was brought to bear upon Congress. The first tangible result of this spontaneous uprising was the organization in the House of Representatives of the forty-fourth Congress of a permanent committee on levees, the first of the kind that had ever been created. This committee framed a bill for the rebuilding of the levees and for the protection of the entire alluvial region from floods, but although it was earnestly and ably advocated it failed to get a third of the votes of the House. The great West was determined that something should be done. At least the mouth of the Mississippi should be made an open gateway to the sea. Capt. James B. Eads, an eminent civil engineer of St. Louis, devised a plan for the accomplishment of this work, which was pressed upon and carried through Congress. The task was entrusted to the man whose genius had devised the plan, and he carried it through to a triumphant success. At last the nation recognized in some measure the importance of the Mississippi river as a highway of commerce.

When the plan proposed by Captain Eads for making a permanent ship channel at the mouth of the Mississippi was first proposed, there were many engineers of eminence who doubted its feasibility, and some of them spent much time and labor in arguing against it. But after the great work had been accomplished and all that its ingenious inventor had promised had been more than fulfilled, the people of the upper as well as the lower valley were inspired with greater confidence than ever that human skill was equal to the task of confining the Mississippi within bounds that it should never pass, to the great advantage of commerce, and to the reasonable security of life and property throughout all the extensive region subject to frequent overflows.

If this could be accomplished there was every reason why it should be undertaken at once, for the rapid growth of the Northwest and the consequent increase of its grain crops made more and cheaper transportation facilities an imperative necessity. From the head of navigation to Port Eads this was the dominant subject of thought and discussion among the people. "The wisdom of Congress should be invoked," said General Garfield, "to devise some plan by which the great river shall cease to be a terror to those who dwell upon its banks, and by which its shipping may safely carry the industrial products of 25,000,000 of people." The people, by popular petitions, by memorials from chambers of commerce and boards of trade, by reso-

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ENGINEERS AT PRESENT OR ORMERLY CONNECTED WITH MISSISSIPPI RIVER IMPROVEMENT UNDER THE MISSISSIPPI RIVER COMMISSION

MAJ. S. W. ROESSLER
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ıtions passed by the State legislatures, did invoke he wisdom of the Forty-fourth Congress. A measure was introduced in that body April 26, 1876, authorizing the President to appoint a commission to improve the Mississippi river. This was referred to the committee on commerce, which invited Captain Eads to present his views as to the proper course to be pursued. That distinguished civil engineer had long been convinced that the conditions that existed at the mouth of the river prevailed throughout its entire length. In a pamphlet published by him in 1874 he stated that the chief portion of the sediment discharged by the river into the Gulf is carried in suspension, and "that the amount of this matter and the size and weight of the particles which the stream is enabled to hold up and carry forward depend wholly upon the rapidity of the stream, modified, however, by its depth." Later, in his review of Humphrey's and Abbott's report on the physics and hydraulics of the Mississippi, he argued on this basis, showing the relation between the current and the suspended sediment, and then demonstrating the practicability of deepening the river and lowering the floods without the use of waste weirs or outlets. Following the same line of argument before the committee, "he held that by applying the jetty system to the river, confining its waters in their highest stages and contracting the channel where unduly wide and protecting the banks against caving, works wholly practicable and inexpensive, a uniform channel might be obtained affording deep water all the year round for the largest vessels to St. Louis, and at the same time and by the same means the slope or flood surface would be so lowered as to prevent destructive floods—floods destructive not only to commerce and trade and the vehicles of transportation, to life and property on the river, but destructive of all government, of all industry, of the property, the earnings, the schools, the churches, the very existence of organized society throughout the wide alluvial region."

In concluding his exhaustive argument Captain Eads said:

"There can be no doubt of the entire feasibility of so correcting the Mississippi river from Cairo to f that a channel depth of 20 feet during the can be permanently secured nd that the alluvial de absolutely safe from overflow without levees by such correction. This can be accomplished for a sum entirely within the ability of the government, and one really insignificant when compared with the benefits which would flow from such improvement.

"Until such work is accomplished, an annual expenditure for the maintenance of the levees is imperative."

It is proper to say that there were some distinguished civil and military engineers, as well as some steamship captains and others doing business on the Mississippi, who held contrary opinions and argued against those of Captain Eads with much earnestness and plausibility. But his views continued to gain ground the more they were criticised, and the emphatic declaration with which he concluded undoubtedly led Congress eventually to enact the law establishing the Mississippi River Commission.

The Forty-fifth Congress, early in its session, enlarged the scope of the committee on levees by adding to its title "and improvements of the Mississippi River," thus enabling it to take jurisdictior of all legislation on these subjects. Many measure were introduced and referred to this committe which finally framed a substitute for them all, e titled, "a bill to provide for the organization of Mississippi river improvement commission, and the correction, permanent location, and deepe of the channel and improvement of the navig of said river and the protection of its alluvial la This substitute was submitted to the Ho Hon. E. W. Robertson, of Louisiana, to who found knowledge on this subject is due the and submission of this important measure

There were many in and out of Cong were willing that whatever money was should be appropriated for improving merce of the stream, who were at the sa posed to any expenditures for the prote alluvial lands. The idea was industr lated by the opponents of all measure ing the Mississippi river, that this b tempt in disguise to recover and immense areas of land belonging to and these insidious attacks had unqu siderable effect upon people who li tions remote from the valley, quainted with its condition and ne chusetts representatives, Messr Banks, each, in advocating the c plained the necessity for the proposed action. Mr. Robinson said:

"The committee have found these two subjects to be interdependent. They have not seen in the investigation they have given that the one necessarily stands apart from the other. All the writers and all the engineers from whom they have heard declare that in some measure, greater or less, the protection of the lands has also an influence upon the navigable character of the river. * * This bill is intended to provide a commission to devise a plan for the improvement of the Mississippi river and the protection of the alluvial lands combined. If as a part of the whole plan for the improvement of the river for the purposes of navigation, and incidental thereto, the lands of the valley may be protected, I am in favor of it."

General Banks, whose campaigns on the lower Mississippi and its tributaries had familiarized him with its conditions and needs, supported the bill ardently, and with patriotic breadth characteristic of that statesman, he said:

"I have already stated that the improvement of the alluvial lands is incidental to this work. It cannot be separated from it. No declaration or act of Congress can prevent it. If we make the river what it ought to be we will make 40,000,000 acres of the best cotton and sugar lands on the face of the earth in consequence of the necessary improvement of the river—40,000,000 where now only 1,000,000 exists. It is inseparable from it and incidental to the improvement of the river."

The late Randall L. Gibson, then a representative, afterward a senator, from Louisiana, who from the beginning had been one of the most intelligent and indefatigable advocates of Mississippi river improvement, said:

"A jetty is a levee, in the popular sense of the word, within the bed or channel of the river, while a levee is a jetty on the bank of the stream. This plan rests upon the theory that in sedimentary rivers, in the Mississippi particularly, as the water is confined its velocity and depth is increased and the surface lowered, and that thus two great objects may be acomplished by one and the same method, namely, 'ease and safety' to navigation and protection to the industrious people on the banks from the dreaded floods."

Representatives by the chairman of the Committee on the Laws and Improvement of the Mississippi River, Hon. E. W. Robertson, of Louisiana, in a speech advocating the appointment of a commission. He said of the bill then pending: "It contemplates the improvement of the chief avenue of transportation of a great commercial nation. It also seeks to protect from floods and pestilence over 26,000,000 acres of the most fertile and productive lands upon the face of the earth. It does not, as is so often alleged, aim at the reclamation of those lands, or seek to perform work which properly belongs to the individual citizen. The word 'reclamation' is not used in this bill. It is well that we understand the distinction at the outset of this discussion, for the wrong use and confusion of terms have given the opponents of river improvement an opportunity to misinterpret, and therefore misrepresent, the object we seek to accomplish. The word 'reclamation' has furnished them with the keynote of unjust criticism. We simply ask protection from the frequent ravages of this great river, over which no power but the General Government has legal control, in order that we who possess lands along its course may have an opportunity to reclaim and cultivate them at our own expense."

But notwithstanding the earnestness of the friends of the measure, and the unanswerable arguments urged in its favor, the bill failed.

At the extra session of the Forty-sixth Congress several new bills were modeled on that which failed, but limiting the field of work. These were followed by one prepared by Representative Gibson, of Louisiana, introduced May 10, 1879, entitled "a bill to provide for the appointment of a Mississippi River Commission' for the improvement of said river from the head of the passes near its mouth to its headwaters." This measure was sent to the committee, was favorably reported back to the House, which passed it the first week in June, with but twenty votes against it. In the Senate it was amended in some unimportant particulars and then passed with but four adverse votes. The House accepted the Senate amendments, the bill was sent to the President, and was approved June 28, 1879. The following is a verbatim copy of this important measure:

[Public—No. 34.]

"An Act to Provide for the Appointment of a 'Mississippi River Commission' for the Improvement of Said River from the Head of the Passes near its Mouth to its Head-waters.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That a commission is hereby created, to be called 'The Mississippi River Commission,' to consist of seven members.

Sec. 2. The President of the United States shall, by and with the consent of the Senate, appoint seven commissioners, three of whom shall be selected from the Engineer Corps of the Army, one from the Coast and Geodetic Survey, and three from civil life, two of whom shall be civil engineers. And any vacancy which may occur in the commission shall in like manner be filled by the President of the United States; and he shall designate one of the commissioners appointed from the Engineer Corps of the Army to be president of the commission. The commissioners appointed from the Engineer Corps of the Army and the Coast and Geodetic Survey shall receive no other pay or compensation than is now allowed them by law, and the other three commissioners shall receive as pay and compensation for their services each the sum of $3,000 per annum; and the commissioners appointed under this act shall remain in office subject to removal by the President of the United States.

Sec. 3. It shall be the duty of said commission to direct and complete such surveys of said river, between the Head of the Passes near its mouth to its headwaters as may now be in progress, and to make such additional surveys, examinations and investigations, topographical, hydrographical and hydrometrical, of said river and its tributaries, as may be deemed necessary by said commission to carry out the objects of this act. And to enable said commission to complete such surveys, examinations and investigations, the Secretary of War shall, when requested by said commission, detail from the Engineer Corps of the Army such officers and men as may be necessary, and shall place in the charge and for the use of said commission such vessel or vessels and such machinery and instruments as may be under his control and may be deemed necessary. And the Secretary of the Treasury shall, when requested by said commission, in like manner detail from the Coast and Geodetic Survey such officers and men as may be necessary, and shall place in the charge and for the use of said commission such vessel or vessels and such machinery and instruments as may be under his control and may be deemed necessary. And the said commission may, with the approval of the Secretary of War, employ such additional force and assistants, and provide, by purchase or otherwise, such vessels or boats and such instruments and means as may be deemed necessary.

Sec. 4. It shall be the duty of said commission to take into consideration and mature such plan or plans and estimates as will correct, permanently locate and deepen the channel and protect the banks of the Mississippi river; improve and give safety and ease to the navigation thereof; prevent destructive floods; promote and facilitate commerce, trade and the postal service; and when so prepared and matured, to submit to the Secretary of War a full and detailed report of their proceedings and actions, and of such plans, with estimates of the cost thereof, for the purpose aforesaid, to be by him transmitted to Congress; provided that the Commission shall report in full upon the practicability, feasibility and probable cost of the various plans known as the jetty system, the levee system and the outlet system, as well as upon such others as they deem necessary.

Sec. 5. The said commission may, prior to the completion of all the surveys and examinations contemplated by this act, prepare and submit to the Secretary of War plans, specifications and estimates of costs for such immediate works as, in the judgment of said commission, may constitute a part of the general system of works herein contemplated, to be by him transmitted to Congress.

Sec. 6. The Secretary of War may detail from the Engineer Corps of the Army of the United States an officer to act as secretary of said commission.

Sec. 7. The Secretary of War is hereby authorized to expend the sum of $175,000, or so much thereof as may be necessary, for the payment of the salaries herein provided for, and of the necessary expenses incurred in the completion of such surveys as may now be in progress, and of such additional surveys, examinations and investigations as may be deemed necessary, reporting the plans and estimates, and the plans, specifications and estimates contemplated by this act, as herein provided for; and said sum is hereby appropriated for said purposes out of any money in the treasury not otherwise appropriated.

Approved June 28, 1879."

NOTE.—This article is from the book on Mississippi River, edited by Frank H. Tompkins and published by the Manufacturers' Record, of Baltimore. Known in Congressional Library as "Tompkins on Mississippi River."

R. S. TAYLOR

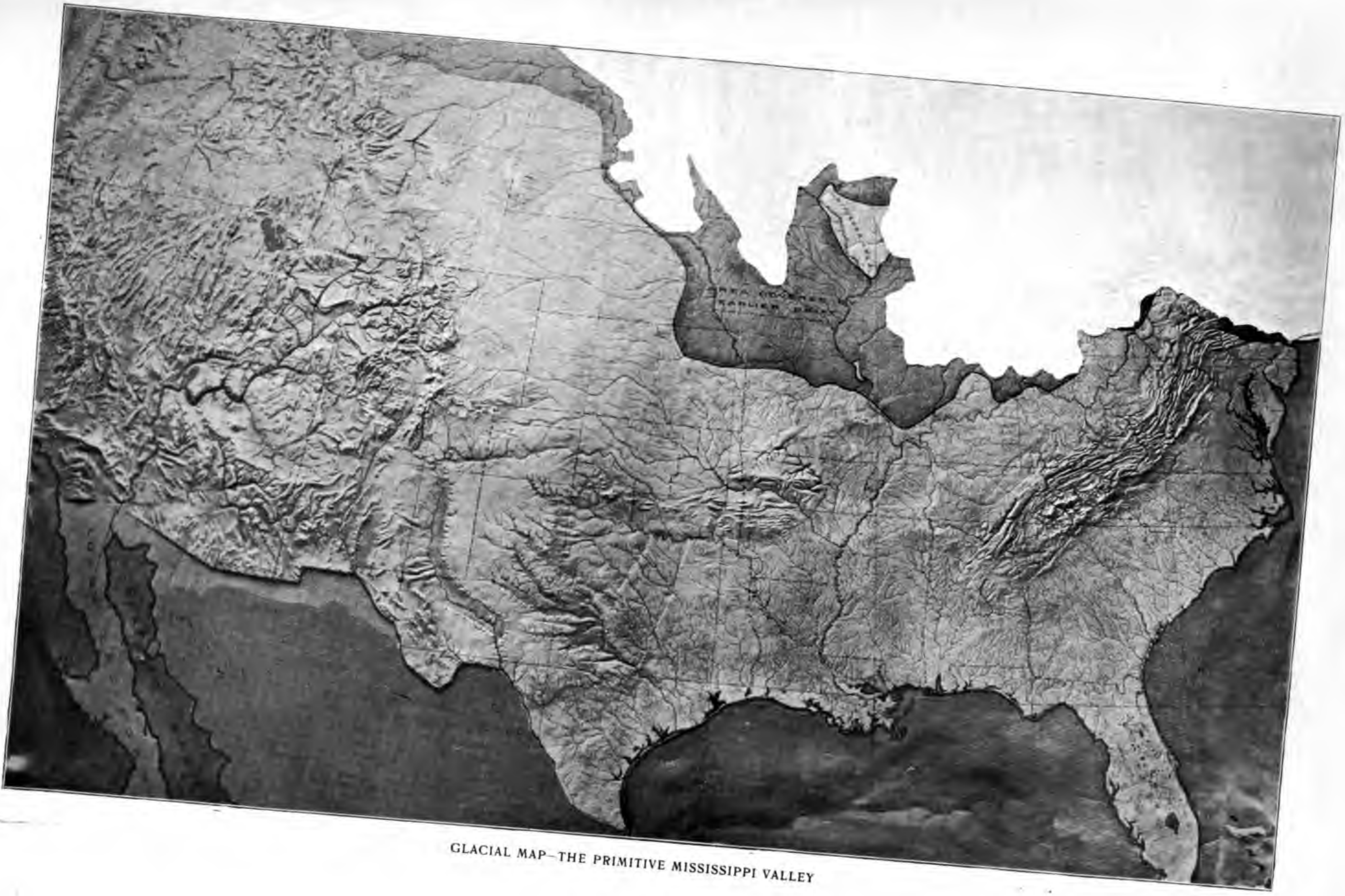
THE MISSISSIPPI RIVER AND ITS LOW LANDS

BY ROBERT S. TAYLOR, MEMBER OF THE MISSISSIPPI RIVER COMMISSION

An inquisitive traveler who should undertake to pace the margin of the Mississippi Valley would begin, we might say, at Decatur, Alabama, and would follow thence the zig-zag crest of the Appalachian range and its northern foot-hills to within less than eight miles of Lake Erie. Passing between its shore and Lake Chautauqua, he would drop southwestward to Crestline, Ohio; thence to Fort Wayne, Ind., and onward past Lake Michigan so close to Chicago that he would see its smoke in the sky as he journeyed. Just missing Green Bay, he would take a bite out of Northern Michigan in order to inclose the Wisconsin River; leave Duluth a few miles to the right; go around the group of lakes in northern Minnesota headed by Itasca; turn abruptly southward a hundred miles or so to Brown's Valley between Lakes Traverse and Big Stone, where companion drops of the same shower part company for Hudson's Bay and the Gulf of Mexico. Thence by the northeast corner of North Dakota, taking a slice out of British America en route, to the Rocky Mountain ravine where Milk River bubbles out of its fountain spring; thence on the backbone of the continent through Leadville, Colo., to Sante Fee, N. M.; thence across New Mexico and Texas between Denison and Dallas to Shreveport and the Gulf. What a wonderful journey to think of, and what an empire in area, population and power it would encompass.

Geologists tell us that the Mississippi River, so far from being the Father of Waters, as the red men called it, is one of the Children of Waters, and among the youngest of the family at that. Which goes to show that to be last is not necessarily to be least among rivers any more than among men. The great Appalachian backbone lifted its skyline high above the sea for centuries of centuries before there was any Mississippi River for De Soto to discover. Down its western slope the Allegheny, Monongahela, Cumberland, and Tennessee Rivers carried the products of erosion into the adjacent sea, where they formed a wide fringing shelf of deposit. After the lapse of we know not how many ages, the earth, in an effort to relieve itself from some intolerable strain, lifted up the bottom of the eastern Pacific and built from it the Rocky Mountain range. Thus was made the western wall of the Mississippi Valley. To fill in the space between this wall and the older one on the east, Nature taxed all her resources of land-building agencies—the frost, the rain, the river, the glacier—decomposing, pulverizing, transporting, and assorting the solid stuff of mountain sides; plants and animals, living, growing, dying, rotting, and mingling their dead tissues with the deader dust of rocks in a soil waiting only the seed of the sower to blossom into new forms of vitality for the use of the heir of the manor, man, when he should come into his inheritance. And so was made the Mississippi Valley—a sub-division of the earth's surface, which, if we take into account its area, the value and diversity of its productions, and the thrift, wealth, intelligence, and progressiveness of its population is without its like on the globe. It is a curious circumstance that the Star of Empire should follow westward the progress of geological land building; and that the geographical area last made ready for occupation by man under favoring conditions should become the seat of his latest and highest achievements in life, liberty, and government.

This stupendous process of land extension has not only come down to an immediately recent geological period, but is in progress yet. At Cairo, Ill., 1,061 miles from the Gulf of Mexico by the windings of the river, is gathered together the surplus rainfall of nearly a million square miles, concentrated by the confluence of the Tennessee, Cumberland, Ohio, Mississippi, and Missouri Rivers; the last two uniting something over 200 miles



GLACIAL MAP—THE PRIMITIVE MISSISSIPPI VALLEY above. Here heads the greater Mississippi. The last remnant of the Appalachian sea was a narrow prolongation of the Gulf of Mexico extending to this meeting ground of rivers, into the head of which they poured their floods in a group of falls or cataracts of sublime grandeur. In the lapse of ages the detritus brought down by them filled this long frith and transformed it into a sloping, alluvial plain having a descent to the Gulf in its 700 miles of length of about 300 feet, and embracing an area of 29,790 square miles subject to overflow in its natural state during great floods.

It is probable that in past ages climatic and geological conditions combined to make this process of transportation and deposit far more active and effective than at present. But it is still going on wherever man has not interfered with it. At the mouth of the river the land is growing outward into the sea. The region south of Red River and west of the Mississippi, known as the Atchafalaya Basin, is in large part in an unfinished stage of development. Large areas in that basin are barely above the sea level.

While the Mississippi is a bold, bad river in many of its ways, there is much to be said to its credit. It and its tributaries furnished the highways by which civilization penetrated the heart of the North American continent. The length and ramification of the navigable waterways which they afford is astonishing. Starting from Cairo steamboats can ascend, and do in fact navigate the Tennessee 349 miles to Florence, Tenn.; the Cumberland 197 miles to Clarksville, Tenn.; the Ohio 967 miles to Pittsburgh, and the Monongahela and Allegheny still further; the Mississippi 929 miles to St. Paul, and the Missouri to the foot hills of the Rocky Mountains. The main stem below is 1,061 miles in length, and its tributaries, St. Francis, White, Yazoo, Arkansas, and Red, are all navigable, some of them for long distances. The total navigable length of all the rivers of the valley has been computed at over 15,000 miles. Except for these natural highways, and the genius of Fulton, who built his steamboat in the very nick of time to fit his country's need of it, this vast region would have remained in the possession of the red men and their wild companions for many years longer than they were able to keep it.

When we consider what the occupation of that valley meant, the homes that were planted there, the states that were founded, the tremendous impulse that was given to the growth of free institutions among men by its marvelous development, we must admit that with all its faults the Mississippi has rendered more signal service to mankind than any other river that flows.

Those were great days—those days of the early settlement of the eastern half of the upper Mississippi Valley. To go home-seeking into the wilderness, to float down noble streams on voyages of discovery, to take possession of the soil as the original occupant was an experience not to be repeated in all its inspiring circumstances. The world has no more such lands awaiting subjugation by civilized man as those which the pioneer found in Tennessee, Kentucky, Ohio, Indiana, and Illinois. The later settlement of the western West of Iowa, Missouri, Kansas, and Nebraska, when emigrants traveled by rail and sent telegrams back announcing their arrival, was swifter in its progress, but it wanted the romance, the poetry, the charm of the real pioneer days,

The divine command to man to subdue the earth grows to mean more and more as the centuries pass by. It seemed to suffice at first to transform forests into cultivated fields. Then roads had to be made, ships built, and steam and electricity broken to harness. In some departments this subjugation of the earth and its forces appears to have reached a degree of completeness. But in one we seem to be ever approaching and never reaching that point. It is in the highways of the water; their lines, channels, and terminals.

The seas, the lakes, and the rivers are the oldest of all the paths of commerce, and still the best, and yet never quite adequate to the demands upon them. A ship can sail round the world to find her voyage stopped by a bar in sight of the quay to which her cargo is consigned. A steamboat would have a thousand miles of unbroken navigation, but for a few piles of sand a few inches too high to let her keel pass over. To deepen and improve river channels and open the doors of harbors are the ever present, ever pressing, never completed problems of modern commercial development.

One of the most notable achievements in that field was the opening of the mouth of the Mississippi by the South Pass Jetties. The history of this great work is not as familiar to the American people as it deserves to be. Twenty years of unobstructed access to New Orleans Harbor has effaced from our remembrance the days when the largest ships never attempted to reach it, and when fleets of the smaller ones that dared try it used to wait outside the bar for days for a favorable tide. The story of the undertaking, the incredulity with which the proposal was at first received, the opposition which it encountered, the halting, hesitating encouragement which it received from the government, the indomitable courage and perseverance of its projector, the marvelous persuasiveness by which he enlisted capitalists in a work in which the contractor took all the hazards of its results, the skill with which he executed it, and the immediateness and completeness of its success, form a chapter of intensest interest in the history of the United States. The Hall of Fame of American engineers will be incomplete without a niche for James B. Eads.

The principal applied in that improvement was simplicity simplified. One of the river's five diverging mouths, or "passes," as they are termed, a small one, carrying only about eleven per cent of the total discharge of the river, was selected. Walls of brush mattresses, cribs, stone, and concrete were built on each side, from the deep water above the bar that crossed it at the line where river and ocean met and the river threw down its sand, across the bar to deep water on the sea side. These concentrated the flow of water within defined lines and extended it farther into the gulf. To increase the velocity of that flow thin brush mattresses were placed across the other passes. These were sufficient to increase the velocity of the current through South Pass only slightly, but enough, with some aid from a dredge, to wash out the obstructing bar, and give free entrance for the largest ships. From the Head of the Passes—that is, from the point where the branching passes diverge—to New Orleans, the river channel is deep enough for the largest ships. And so the world's commerce found access to New Orleans Harbor.

The fluid which flows down the Mississippi is called water by courtesy; it is really a mixture of water and earth—enough earth to give it the color of mud, but not quite enough to give it the consistency of soup. A tumblerful of it, after standing a few hours, will precipitate a teaspoonful of settlings of the fluidity of hotel cream. The quantity of earthy matter thus transported is enormous. It is equal in bulk to one part in 2,900, and in weight to one in 1,500 of the total average volume flowing. At an active rising stage the sediment carried past a given point is equal to a thousand tons a minute. If at such a point a screen could be placed across the river that would filter the water perfectly without checking its flow, there would be enough earth accumulated to make a wall across the entire channel a foot thick in eight minutes. If the total amount which is in suspension and course of transportation at a given moment between Cairo and the Gulf at ordinary stage could be gathered together as dry land by a flash of lightning, it would weigh over sixteen million tons and would cover six thousand acres of land a foot deep with prime garden soil.

This carrying capacity of the river depends upon the velocity of its flow. When it is loaded to its maximum at a given velocity any diminution of that velocity compels it to drop part of its load. And it drops first, of course, the heavier particles, such as coarse grains of sand, carrying the lighter particles further on.

As has been stated, the alluvial valley of the Mississippi from Cairo to the Gulf is an old frith filled up by the deposits of the rivers which empty into it. This valley varies from twenty to forty miles in width, and the river descends it by a path which touches the bluff on either side only at a few places, and then only for a few thousand feet, and is so full of crooks and turns that a steamboat will box the compass several times round in going down it once.

This tortuous channel is entirely of the river's own making; sides, bottom, width, depth, direction—everything. Every spoonful of earth in the valley was brought to the place where it is by flowing water. It stopped at the place where it is because the velocity of water was insufficient to carry it further. Every square foot of the face of every vertical bank on the river is exposed as it is, because the river has cut away the earth in front of it just that far. If the velocity of the water had been greater, the erosion and retreat of the bank would have been greater; if less, less. Or if the resistance of the bank had been greater, the erosion would have been less, and vice versa. In short, every feature and circumstance appertaining to the river is a resultant of opposing forces, but represents some degree or kind of equilibrium between such forces.

If the bed of the Mississippi River could be emptied of its contents so as to expose its bottom dry and bare, the appearance presented would be surprising to most of us. Instead of a comparatively level channel floor there would be found a succession of great sand hills and intervening depressions. Passing through one of these depressions, the observer would find himself, it might be, a hundred and fifty feet below the banks on either side. Within a few thousand feet we would encounter a sand hill stretching across the channel, so steep that you could scarcely drive a horse up its declivity, and perhaps a hundred feet high. Having crossed the top of this he would descend into another basin, then climb another hill, and so on. When the channel is filled with water the crests of these elevations approach the surface and constitute the bars which obstruct navigation.

The action by which these bars are produced is somewhat as follows: At flood stage a volume of water several times as great as that which goes over Niagara Falls drops 322 feet in flowing from Cairo to the Gulf. Its path is a series of alternately reversed bends. In these bends it hugs the concave bank, flowing with high velocity and scouring out of the bottom of the channel and from the face of the bank a greater or less, and sometimes a very great quantity, of sand and loam. At the foot of each bend the main flow crosses to the other side of the channel and follows the concave bank on that side; and so back and forth from bend to bend. The place in the channel where the flow thus crosses from the concave face at one bend to the concave face of the next bend below, is called, in the vernacular of the river, a "crossing."

As the water passes over the crossing the velocity of its flow falls off a little, to be renewed again in the bend below. This slackening need be very little to cause the flowing water to let fall part of the lead of sand and loam which it has taken up in the bend above, the larger and heavier grains of sand going to the bottom first. And thus are built up the bars between the bends.

There is a bar of some dimensions between every two bends on the river. But most of them never rise to a height to present any obstruction to navigation. Over some of them, however, the water becomes very shallow at extreme low stages, spreading out in a broad sheet, it may be a mile wide and less than six feet deep. Of such obstructing bars about forty have been known below Cairo.

For about eight months in each year the volume of water passing down the river is sufficient to submerge all the bars deeply enough for all the requirements of navigation. But unfortunately, the lowest water usually comes in the late fall and early winter, when there is greatest need of a good channel. It is then that the grain and cotton crops of the valley are ready for market and ample and cheap means of transportation are of the highest value to the people.

It will be seen from this description that the problem presented is to cut off the tops of the bars, or sand hills, which the river builds between the pools of its own bends. The quantity to be taken off is not great compared with the whole height of the bar—say fifteen feet from the top of a sand hill a hundred feet high in order to secure a channel twenty feet deep.

These obstructions are found for the most part in groups of from three or four to eight or ten embraced within a reach of twenty to forty miles in length. The first of these groups is in the vicinity of New Madrid, Mo., and the next about a hundred miles above Memphis. Between its bad places the river will show a good channel at all stages for long distances. Careful comparative study of the good and the bad reaches shows that an obstructing bar is usually the result of one or the other of two combinations; a series of rapidly caving bends with broad bars at the crossings between them, or the subdivision of the low water channel into a number of relatively small ones. Where the low-water discharge crosses the bar by a single channel of three thousand feet or less in width there is always ample depth for navigation.

As soon as the success of the South Pass Jetties was demonstrated the question was asked, Why not apply the same principle to the removal of the bars in the channel? Mr. Eads was of the opinion that it could be done, and engineers generally agreed with him as to the applicability of the principle. The question of cost was in doubt. No data existed on which to base a final estimate.

At the same time another great interest demanded attention—the protection of the alluvial lands below Cairo from overflow. Prior to that time two opposite theories in regard to the control of floods in the Mississippi had found supporters. One was known as the outlet theory, the substance of which was, that the remedy for overflow was to give the river more channels to the sea by making outlets in its banks where it was possible to do so in a way to take off part of a flood and carry it to the Gulf by an independent path. The other theory, which may be called the concentration theory, had for its main principle the proposition that the scouring power of the river increases with its discharge and, vice versa, that a given volume of water flowing in two channels has less capacity for scour than if flowing in one channel, and that the best security against floods is to keep the main channel open by concentrating the whole discharge of the river in it at all stages.

It followed from this view that the concentration of the water at flood stages in the main channel by means of levees would not only protect the alluvial lands from overflow, but would tend to improve the channel for navigation by increasing the scouring power of the current.

At this juncture, by an act of Congress approved 1879, the Mississippi River Commission was created. In its first report it set forth a plan for removing the bars from the river by means identical in principle with the South Pass Jetties, to be supplemented by levees which would confine all ordinary floods within the channel. Mr. Eads was a member of the commission and the plan of improvement adopted was in accord with his views, but not without some dissent by other members. A provisional estimate was made of the cost of the channel work (by which is signified the engineering constructions placed within the banks, as distinguished from the levees) at $33,000,000. In this estimate the cost of bank revetment (by which is meant the protection of mattresses and riprap, or spur dikes, applied to the bank to prevent caving) was estimated at twelve dollars per running foot.

While the construction of the engineering devices known as revetments and contraction works are familiar to those who have followed the course of the work done on the lower river they may not be known to others who will read these pages, and a brief description of them will not be out of place.

The object sought, it is to be noted, was to concentrate the current over the bars within a width of about three thousand feet. This required two kinds of work. First, a contraction of the channel where its width was excessive, and, second, the prevention of excessive caving in the bends whence the material of the bars is obtained. There is at all times, and in all parts of the river, a large quantity of sediment in suspension ready to be deposited whenever the velocity of the current falls below the point necessary for its transportation. Of this the solid particles of sand are the coarsest and heaviest. Much of this, indeed, is not carried at all, but rolled along the bottom. So that, as a rule, the greater part of the material of the bars comes from the bends immediately, or only a little way above them. Hence, the stopping of caving in the bends cuts off in large measure the supply of material for the building of bars.

There is no foundation in the bed of the Mississippi River upon which to build structures of stone or timber; and if there were, the cost of them would be prohibitory. So resort is had for material to the willows which cover thickly the islands and low banks of the river—the hair of the same dog, as one might say.

The method of using these for the contraction of the channel is as follows. Above the space which it is desired to fill in order to reduce the width of the channel, rows of piles are driven and between these are interwoven long, slender willows like basket work, so as to make a sort of open screen through which the water can pass freely, but which checks sensibly the velocity of its flow. These structures are known as "permeable dikes." As the water approaches them it brings a load of sediment as great as its velocity will support. The reduction of its velocity in passing through them diminishes its silt-carrying power and causes it to deposit part of its load in the space below. The results attained by these simple structures are sometimes truly wonderful. In some instances thousands of acres have been filled several feet in depth in a single season—the material all picked up and laid down by the water itself, a speck at a time.

For the prevention of caving in the bends, two forms of protection are employed. The one most used is the woven mattress. The manner of its construction may be described as follows: A strong barge (or two or more of them placed end to end) is moored in the stream with one end resting on the shore and the other extending into the stream at a right angle with the bank. The down stream side of this barge slopes toward the water like the roof of a house, and has at intervals of a few feet elevated tracks or ways which lead down to the water like the hand-rail of a stairway. Above these inclined ways is a broad horizontal deck on which are mounted some simple mechanical devices for weaving together the wire, slender poles, and brush, of which the mattress is made, with room for a large gang of men to work. As the weaving

PROTECTION OF MEMPHIS HARBOR

TWO SCENES OF REVETMENT WORK
AT HOPEFIELD POINT

progresses the mattress slides down the ways into the water and floats on the surface. It forms a compact, strong, and yet flexible structure, a foot or more in thickness, and as it gradually extends its length down stream the workmen walk upon it with freedom and safety. A usual size of a completed mattress is 300 feet in width by 1,000 to 1,200 feet in length—without doubt the largest textile fabric ever made in the world. The art of building and using such mattresses is not new, but they have never been made of such size and strength anywhere else as on the lower Mississippi. In the great sweep of its bends the revetments required are often several miles in length.

When the weaving is complete the mattress is loaded with stone in large fragments scattered evenly over its surface in just sufficient quantity to overcome its flotation, and it slowly sinks to the bottom. Its outer edge is securely held at the low water margin of the stream. Inside that line it follows the curvature of the submerged bank to the extent of its width, the intent being that it shall reach the foot of the subaqueous slope.

That portion of the bank above low water mark is graded to a flat slope by hydraulic graders of great size and power and the surface of the slope covered with a riprap of stone. The entire combination of mattress, grading, and riprap is comprised under the general term "revetment."

The other form of bank protection employed is known as "spur dike revetment," and consists of short spurs projecting from the bank at intervals of a few hundred feet. These spurs are built up of alternate layers of brush work and stone, beginning with a broad mattress at the bottom and tapering to the top in pyramidal form. The brush work employed is substantially like that found in the mattresses just described, except that larger poles are used and greater strength and thickness are required. The effect of the spurs is to break the force of the attack upon the bank at intervals so short that after wearing back a certain distance between them its caving ceases.

These structures—the permeable dikes, or contraction works for bank building, and revetments, whether of mattresses or spurs, for bank protection, are all comprised in the general term "channel works," and constitute one main division of the work done under the supervision of the Mississippi River Commission. The other main division consists of levees to prevent overflow. A Mississippi River levee is no more than a bank of earth not unlike a railroad embankment except that it is broader at its base and flatter in its slopes. The standard form, as at present built, has a crown, or top surface eight feet wide with side slopes of three feet horizontally to one foot vertically. If it exceeds eight feet in height the most perfect construction includes a banquette, or annex on the inner side in the form of a terrace coming to within eight feet of the top and extending inwardly with a very flat slope for twenty feet or more.

These embankments do not follow closely the curves of the river, but are located at distances from the bank varying from a hundred or a few hundred feet to several miles, the object being to economize in length and to keep away as far as possible from rapidly caving banks.

The construction of levees to prevent overflow began with the Spanish settlements at New Orleans a hundred and eighty years ago. From thence they advanced up stream, as the country was occupied, until, at the outbreak of the civil war, they were substantially continuous as far up as the mouth of the Arkansas River on the west side, and Memphis on the east side. During the war the leveees suffered great destruction, and it was some years after its close that the work of their restoration was taken up with any effectiveness.

The first appropriation made by Congress for work under the Mississippi River Commission was $1,000,000 by act of March 3, 1881. It was expended in the construction of plant for use in the channel works, and in beginning those works in two selected places on the river where the worst bars were found—one at what is known as Plum Point Reach, about seventy-five miles above Memphis, and the other at Lake Providence Reach, a similar distance above Vicksburg. The second appropriation was of $4,123,000 by act of August 2, 1882. From that appropriation the sum of $1,300,000 was allotted to the repair and maintenance of levees, and the remainder to channel works, and expenses incident thereto, and harbor improvements. In the expenditure of the sum allotted to levees the Commission began at once a policy which has been followed ever since, of co-operation with the state and local authorities interested in the work. Preference was given, other considerations being equal, to those localities where the people were ready to contribute most to the work from their own resources.

The time was opportune for this co-operation. The people of the lower valley had been exerting themselves to the utmost for a number of years to restore the levee system to its ante bellum conditions, and had accomplished much in that direction. The extraordinary flood of 1882 — the greatest known in modern years, had all but destroyed the entire system. The people were exhausted, prostrate and disheartened. The appearance in the field of the United States Government with its proffer of aid awakened hope in their hearts and stimulated them to renewed effort. The most efficient local organizations were in Louisiana and Mississippi, and there the response of the people to the invitation of the Government was immediate and vigorous.

In the earlier years of the work of the Commission levees were treated as an adjunct, merely, of the channel works. It was considered that they contributed to the deepening and improvement of the navigable channel by concentrating the flood discharge within defined lines and so increasing its scouring power. It was partly in order to obtain the benefit of this concentration of flow in those parts of the river where the channel works were inaugurated, and partly because there was also in those parts the greatest readiness and ability to co-operate in the work by the riparian communities, that the largest expenditures in the early days were along the Mississippi and upper Louisiana fronts.

The importance of the work which was then begun, and which has been continued for eighteen years will not be realized without an adequate conception of the conditions presented, the interests at stake and the results which have been accomplished. There are few such regions in the world as the twenty-nine thousand square miles comprising the alluvial valley of the Mississippi. Its area is equal to two and a half times that of the kingdom of New Netherlands, which contains a population of five millions of people. It extends through eight degrees of latitude. Its northern portion produces corn, wheat and oats, its central portion cotton, and its southern portion sugar and rice — all in crops yielding rich returns to the planter.

This wonderful valley is the cream jug of the continent. Nature knows not how to compound a richer soil. It can no more lie idle than the sea can keep still. Every square foot of it riots in vegetable life. In its natural state, before its invasion by civilized man, lofty forests, interminable in extent; climbing, crawling, wandering vines; thick undergrowth, cane brakes and tall grasses fought for room in its earth and air. Its floods came down loaded with skimmings from the great watershed above. Overtopping its banks, the enriched water spread far and wide over the alluvial area, so obstructed in its flow by the dense growth covering the land that its slackened velocity compelled it to let fall its load of sediment as it went. Thus the floods built up the valley year by year in layers of fatness to live again in incalculable crops of grain, fruits and fibers. Such an alluvial empire, such a field of opportunity for enterprise and industry, such resources of supply for human enjoyment can not be abandoned to floods and uselessness if it is possible to save it. The world can not spare it.

It can be saved and made to blossom as a garden over its whole vast expanse by levees of such proportions as to confine its floods within its channel, and in no other way. All schemes for reducing overflow by outlets are futile and visionary. They only weaken the carrying power of the water and result in increased deposits and higher flood levels in the end.

There have been plans for alleviating floods by impounding the surplus rainfall in reservoirs at the head waters of the upper Mississippi and the Missouri. But they are unavailable because the overflowing floods do not come from those parts of the valley. They come from storms that originate in the southwest and cross the Ozark mountains into the valleys of the Tennessee, Cumberland and Ohio. It is on the steep declivities of the Appalachian range, and in the thickly populated, highly cultivated states of Tennessee, Kentucky, Ohio, Indiana and Illinois that the reservoirs would have to be located. As an engineering problem simply, the thing is not impossible; as a practical solution of the question it is impossible on account of the expense and the destruction of vested rights which it would involve.

The latest and most nearly feasible of all suggestions of this sort is to use the St. Francis Basin as a flood reservoir. This has in it enough of imaginable possibility to call for the specific study which can be given to it only by means of a detailed survey for the purpose, which will doubtless be made. In advance of that it must be said that the danger of impounding such a sea within earthen embankments high above the heads and homes of

CONCRETE WORKS AT BONDURANT, LA.

KEMPE LEVEE 1899

millions of people, and the probable insufficiency in storage capacity of the deepest reservoirs that could be made in that basin, will make it only a little less impracticable than the other reservoir schemes which have been discussed. The co-operation begun eighteen years ago between the United States and the state and local authorities in the building, and maintenance of levees has continued to this time. It has been a great partnership in a great work, which has borne fruit in great results. The levees now extend in nearly complete lines from the Forts, seventy miles below New Orleans, to the high ridge near New Madrid, seventy miles below Cairo, comprising in all fifteen hundred miles of embankment. There are a few gaps to be filled, not exceeding fifty miles in the aggregate, and sixty-five miles yet to build above New Madrid, to cover all the great basins. A small area above Reelfoot Lake should be closed, and there are some fragmentary areas, on the east side below Vicksburg, scarcely worth the cost of levee protection, which still remain open; and nearly all the lines want additional height and strength to hold the extraordinary floods which sometimes occur. They are adequate now to restrain ordinary high water, and have done so already.

The flood of 1897 was of extraordinary height and duration—in many parts of the river the highest ever known. It made a number of crevasses and inundated about one-third of the area subject to overflow; but less than one-fourth of the cultivated lands. Nevertheless it was a demonstration of the possibility of effective protection by levees. Out of 1,377 miles of embankment in place, only 8.7 miles, or .63 of one per cent of the whole, was destroyed. Nearly all the crevasses were in old, weak lines, or lines so far below grade that the water overtopped them. Below Red River the entire discharge passed down to the sea without a crevasse except one of insignificant dimensions, which was closed in short time. Taken as a whole, the record of the flood showed that, barring accidents, if the levee system had been complete in accordance with the standards now in force it would have held the water. As it was, the saving of property by the levees during that single flood was equal to the cost of the levees, as they then stood. The flood of 1898 reached a height of 49.8 feet at Cairo, against 51.6 in 1897, and at several points below reached a higher stage than that of 1897, or any previous year. But it flowed to the Gulf without a break—the first time in history that such a thing has occurred. Since then there has been no overflowing flood.

The total expenditure on the levees since 1882 has been approximately $35,000,000. Of this the United States has supplied $15,000,000, and the people of the valley $20,000,000, as nearly as can be estimated. As the work has progressed, and the people have come to have more and more confidence in the stability and effectiveness of the levees, the alluvial valley has undergone a transformation. Population has increased—in some parts doubled within ten years, thriving towns have grown up, railroads have been built, banks opened, new industries established, new plantations cleared, and a great impetus given to life and business in all departments. It is entirely within bounds to say that the total value of property in the valley has doubled since 1882.

A feature of special interest in this connection is the opportunity which the reclamation of the alluvial valley offers to the negro to better his condition. One-half or more of its entire area is suitable for cultivation of cotton. A bale per acre of ginned cotton, weighing five hundred pounds, is the standard yield—worth from thirty to fifty dollars according to the ups and downs of the market. In addition to this the seed has a value of five or six dollars per acre. Its cultivation is as simple as that of corn. The picking season lasts three or four months, so that no extra help is required in harvesting it. One man, with the aid of his wife and children, can raise and gather the crop from ten acres. It is an ideal industry for the negro.

The restraint of the floods has not only afforded new security to the lands formerly cultivated, but has made available as much, or twice as much more in area which was never before utilized. The surface of the valley is not an even plain, but a succession of low ridges along the banks of the river and the interior bayous, with broad areas of wooded swamp land between. In former years no attempt was made to cultivate anything but the ridges. Since the completion of the levees the lower lands are rapidly coming into use, first for the timber with which they are covered, and then for cultivation.

The timber industry has assumed great proportions. The supply is enormous. Without railroads it was inaccessible away from the banks of streams. Without protection from floods railroads were impracticable. They are now being rapidly extended over all the alluvial district. For the moment the timber industry rivals cotton in its importance. After it follow cotton and corn. When the merchantable timber has been removed the clearing of the land is an easy task, and what were formerly hopeless swamps become the most productive fields.

The negro is not seizing this golden opportunity as the white pioneer of the Northwest would have seized it, but he is not wholly neglecting it. In considerable and increasing numbers they are buying land and becoming independent cultivators. Those who do so are steadily advancing in thrift, intelligence, and the qualities of good citizenship. Nowhere else in the South are as favorable opportunities offered to the black man as in the reclaimed Mississippi lowlands, and nowhere else is he doing as much for his own uplifting.

The history of the channel works has been one of varying experiences. It was soon seen that the work undertaken was more difficult than that done at the jetties. At the mouth of the river only one bar required removal. But the interests involved were so important that the Government could well afford to pay five million dollars for a channel through that one bar. The water over it was subject to little rise and fall and its current was gentle and uniform. In the river above there were to be encountered stages of water varying forty feet and more between extremes, and currents of high velocity and shifting directions. The bank ranged in composition from clear sand to "buckshot" as tough as the Northern blue clay. Contraction works and bank revetments had been built before, but never on such a scale and in such situations. The work was an experiment from the start.

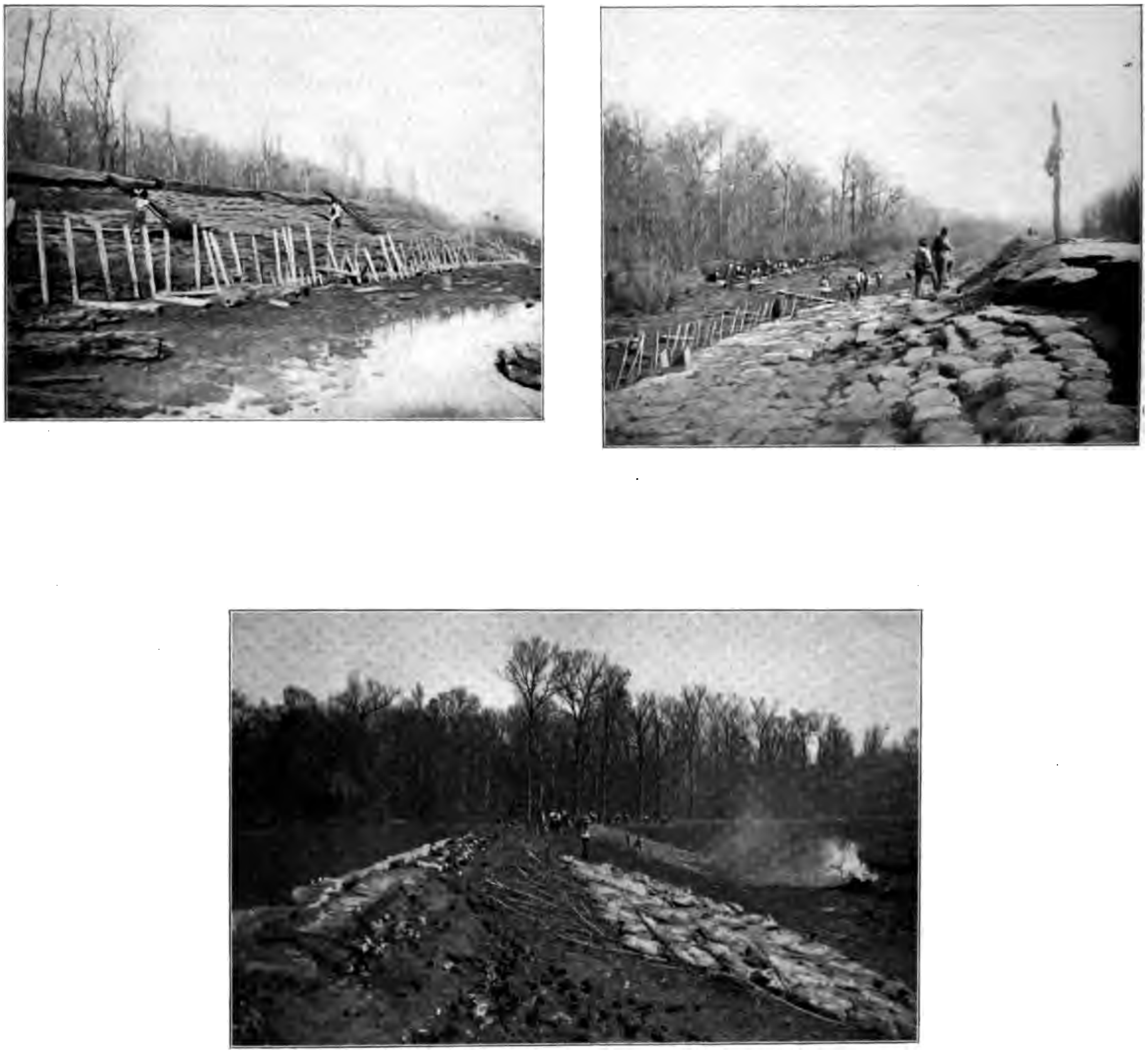
It developed at once that the bank revetments were the most important and the most difficult part of it. The first ones failed. Better ones were made. It was a problem to learn how to make them and get them into place with one edge at the water line and the other sixty feet under water in a current boiling and swirling round a bend. It called for invention, courage, skill, and perseverance. But as occasion demanded the art grew. And the mattresses grew. From structures a hundred and twenty-five feet wide and three or four hundred feet long that went out, they developed to structures three hundred feet wide and twelve hundred feet long, that stayed where they were put. The standard mattress of to-day is an evolution. It is a piece of work that no one in the world could have made and laid down fifteen years ago. Other descriptions of it with illustrations will be found in this book.

When, after years of study and experiment, it was demonstrated that a caving bank can be held, it was also demonstrated that the cost of doing it will reach thirty dollars per running foot. This was two and a half times the original estimate. It became apparent, also, that the time which would be required to remove by these permanent improvements the forty bars that impeded commerce between Cairo and New Orleans would be longer than impatient commerce could afford to wait.

Happily, just as this discouraging condition had forced itself on the minds of those in charge of the work an unexpected alternative presented itself. The hydraulic dredge appeared among the gigantic machines born of modern invention. Why not try it on the Mississippi bars? Once cut across the crest, would not the current keep its path open? It must be done quickly, else the cut would fill at one end before it would be open at the other. How quickly could it be done? A dredge was built and tried. The results were encouraging, but inconclusive. It was determined to press the experiment by building at once a more powerful machine than any previously known.

In 1895-6 Mr. Lindon W. Bates, of Chicago, built for the Commission a dredge having more than twice the capacity of any other dredge then existing. On its trial tests it handled in an average of ten tests the astonishing quantity of 4,921 cubic yards of sand per hour, taking it up from the bar and transporting it through floating pipes to a distance of one thousand feet. While this was far above its subsequent performance in actual work it was an invaluable demonstration of possibilities, and settled the question of the feasibility of cutting through a bar so quickly that the current can establish itself in the path thus offered to it before the drifting sand will fill it up.

This dredge—the Beta, was a twin machine, being, in reality, two independent dredges mounted on one hull. For reasons of convenience in handling no more like it in that respect have been built; but others similar in general design, with improvements suggested by experience, have been added until a fleet of eight powerful hydraulic dredges are

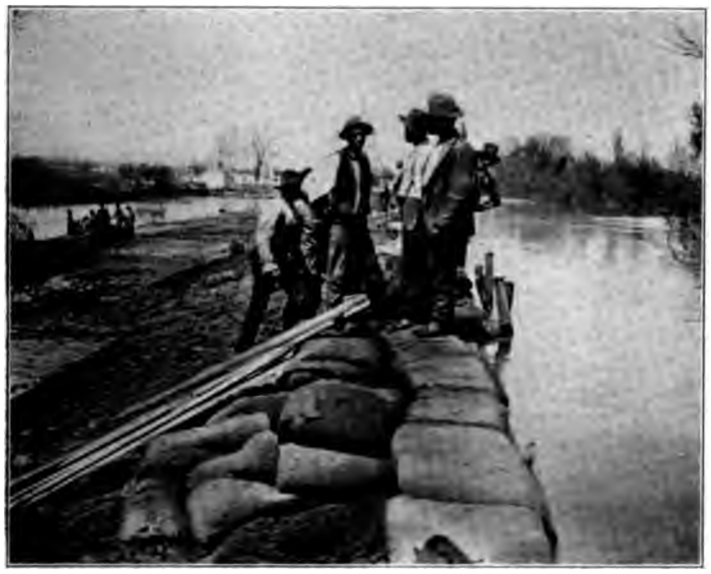


FORTIFYING LEVEES WITH SACKS OF EARTH, IN CASES OF SLOUGHING OR WEAKENING now employed at low water in the channel below Cairo. The purely experimental stage of the work has been past, and its probable success has been assured. By these Titanic machines paths are opened across the bars as the river falls to which it takes kindly and in which it keeps its course throughout the season with ample depth for navigation.

These dredge channels are not relied on for more than a single season's service, although in some places considerable traces of them survive the following flood. There is reason to believe that as the very nice art of locating them in harmony with the natural tendency of the river is perfected by experience they will gradually become more and more permanent. This result will be promoted where conditions are changeable by channel works suitable to preserve general stability. With these more or less temporary channels to meet its immediate needs commerce awaits the slower process of the permanent improvements to follow.

As a whole, the work of improvement in the alluvial valley of the Mississippi inaugurated twenty years ago has demonstrated its utility in results already gained and far greater ones in reasonable prospect. It furnishes a vast object lesson in the value of union and co-operation. It is not probable that the dwellers on the banks below Cairo could ever have enlisted the aid of the United States in reclaiming their lands through their own exertions; and without that aid they could not have accomplished the work. It is also not probable that the commercial interests of the upper valley, acting alone, could have secured the appropriations necessary for the improvement of the lower river as a highway of navigation. But when all the Mississippi states, from Minnesota to Louisiana, pull together, Congress heeds. Nor is it for themselves alone that these great states join in heart and hand and effort. It is for all the people of the whole Union that the Mississippi flows and its lowlands blossom and their harvests ripen.

STEAMER MISSISSIPPI



No. 1

No. 2

No. 3

NOS. 1 AND 3—LEVEES RAISED BY MEANS OF SACKED EARTH TO KEEP PACE WITH THE RISE IN THE RIVER

NO. 2—STRAIGHTENING LEVEES WITH SACKS

CAPITOL OF THE UNITED STATES, WASHINGTON, D. C.

SENATE CHAMBER, CAPITOL, WASHINGTON, D. C.

HALL OF THE HOUSE OF REPRESENTATIVES, CAPITOL, WASHINGTON, D. C.

SOME OF THE PROMINENT MEMBERS AND EX-MEMBERS

OF THE

United States Senate and House of Representatives

FROM THE STATES AND DISTRICTS EMBRACING THE

RIPARIAN LANDS OF THE MISSISSIPPI RIVER

NOTE.—Portraits of Senators Vest of Missouri and Caffery of Louisana are in the Group Representing the Senate Committee on Commerce .˙. .˙. .˙. .˙. .˙.

N. C. BLANCHARD
Justice of Louisiana Supreme Court, Ex-Representative and Ex-Senator from Louisiana

T. C. CATCHINGS
Representative from Mississippi

THE LATE EDWARD CARY WALTHALL

Senator from Mississippi

EDWARD DOUGLAS WHITE

Associate Justice U. S. Supreme Court
Formerly U. S. Senator from Louisiana

THE LATE RANDELL LEE GIBSON

Representative and Senator from Louisiana

THE LATE JAMES Z. GEORGE

Senator from Mississippi

THE LATE EDWARD WHITE ROBERTSON

Representative from Louisiana

BENJAMIN F. JONAS

Ex-Senator from Louisiana

THE LATE JAMES PHELAN

Representative from Tennessee

MATT. D. LAGAN

Ex-Representative from Louisiana

THE LATE EDWARD J. GAY
Representative from Louisiana

H. DUDLEY COLEMAN
Ex-Representative from Louisiana

ANDREW PRICE
Ex-Representative from Louisiana

SAMUEL M. ROBERTSON
Representative from Louisiana

JOSEPH W. BAILEY

Representative from Texas
Democratic Leader in 55th Congress
Will be elected to U. S. Senate from Texas

WILLIAM B. BATE

Senator from Tennessee

JAMES K. JONES

Senator from Arkansas

EDWARD T. LEWIS

Ex-Representative from Louisiana

JOSIAH PATTERSON
Ex-Representative from Tennessee

THOMAS B. TURLEY
Senator from Tennessee

THE LATE WILLIAM H. CATE
Representative from Arkansas

JAMES D. RICHARDSON
Representative from Tennessee
Democratic Leader in the House of Representatives

RICE A. PIERCE
Representative from Tennessee

WILLIAM V. SULLIVAN
Senator from Mississippi

SAMUEL DOUGLASS M'ENERY
Senator from Louisiana

HERNANDO DESOTO MONEY
Senator from Mississippi

WILLIAM D. VANDIVER
Representative from Missouri

GEORGE W. SMITH
Representative from Illinois

PHILIP D. M'CULLOCH
Representative from Arkansas

THOMAS C M'RAE
Representative from Arkansas

EDWARD W. CARMACK

Representative from Tennessee
Will be Elected to the U. S. Senate

ADOLPH MEYER

Representative from Louisiana

ROBERT C. DAVEY

Representative from Louisiana

CHARLES F. BUCK

Ex-Representative from Louisiana

THE LATE SAMUEL T. BAIRD
Representative from Louisiana

ROBERT F. BROUSSARD
Representative from Louisiana

RICHARD BARTHOLDT
Representative from Missouri

CHAMP CLARK
Representative from Missouri

JOSEPH E. RANSDELL
Representative from Louisiana

THEODORE S. WILKINSON
Ex-Representative from Louisiana

JOHN SHARP WILLIAMS
Representative from Mississippi

CHARLES J. BOATNER
Ex-Representative from Louisiana

ANSON J. M'LAURIN
Senator-Elect from Mississippi

MURPHY J. FOSTER
Senator-Elect from Louisiana

M. R. PATTERSON
Representative-Elect from Tennessee

CHARLES F. JOY
Representative from Missouri

CHARLES E. HOOKER

Representative-Elect from Mississippi
(Previous Service of Many Years)

PATRICK HENRY

Representative-Elect from Mississippi

HENRY W. OGDEN

Ex-Representative from Louisiana

PHANOR BREAZEALE

Representative from Louisiana

L. W. BROWN

PROTECTION OF CITIES AGAINST ENCROACHMENT OF THE MISSISSIPPI

BY L. W. BROWN, C. E., MEMBER AM. SOC. C. E.

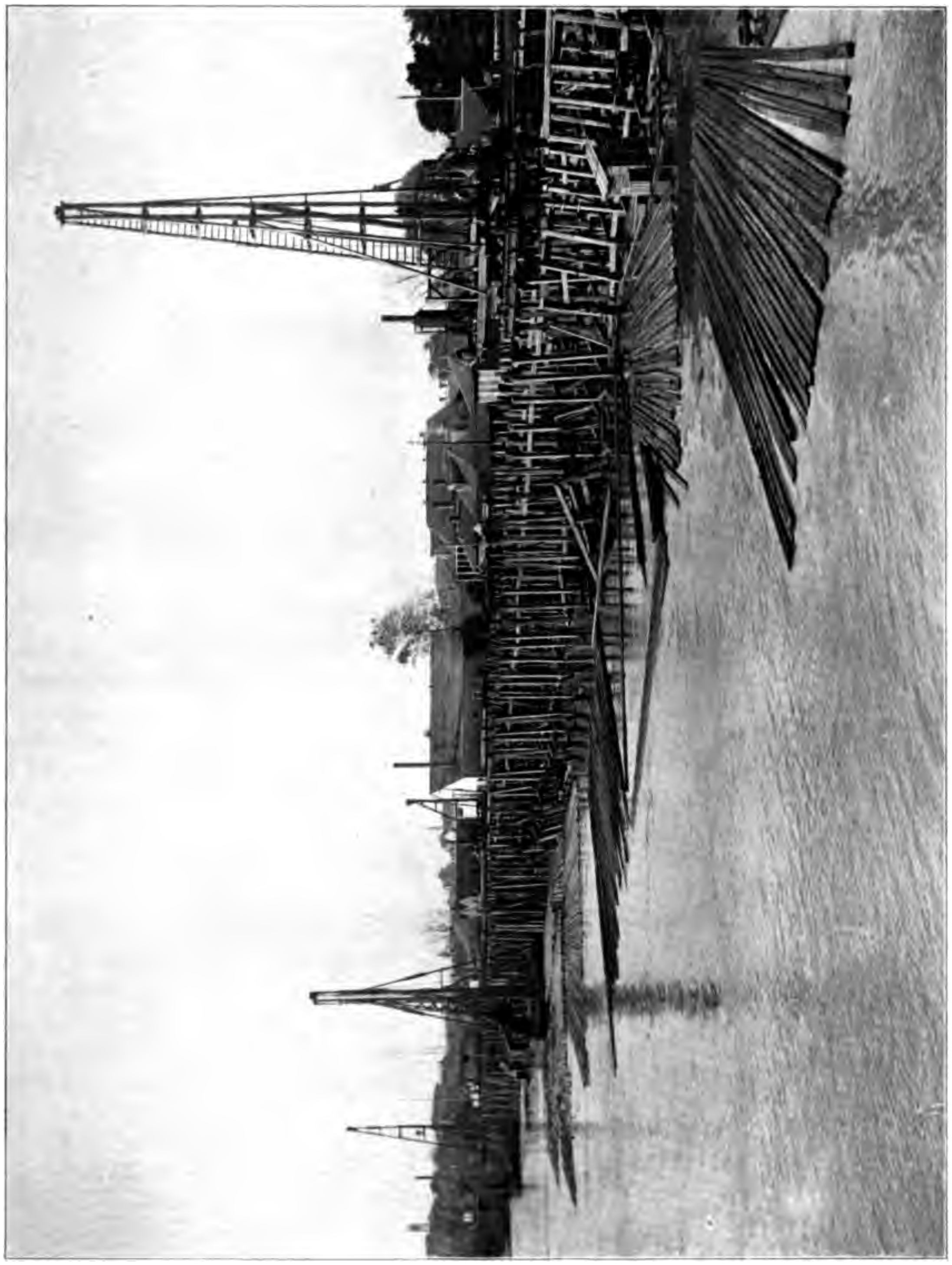
The great hardship, injury and detriment to the prosperity and value of the commerce of cities located on the Mississippi River, resulting from insecure wharves and landings, due to the constant changing of banks of the river, warrant the most thorough consideration of measures having for their object an amelioration of the existing conditions.

Permanent wharves and landings not only attract commerce to a port, but materially reduce the cost of handling, and thus make trade and prosperity. Hence, unless permanent wharves and landings are secured, commerce will be gradually deflected to other ports where permanent conditions are secured even if greater expense is entailed by reason of more circuitous route. As an illustration: a shipper who has large shipments of goods that cannot be exposed to the weather, such as wines, etc., and who is willing to expend thirty or forty thousand dollars for covered sheds or suitable warehouses adjacent to landings on which to store his shipments, finds that the water rates to New Orleans are considerably cheaper than to other ports, and he decides to ship to New Orleans and makes arrangements accordingly. But when he comes to investigate he finds that the banks of the river and landings are not permanent and he has no security that the sheds or warehouses he erects at a cost of thirty or forty thousand dollars will not within three years' time be either in the river or three squares from the river and thus render his investment valueless for the purpose designed. As a consequence he determines that it is economy to go to other ports where he has a guarantee of stability even at an increased water rate. Thus the port of New Orleans, or any other port located on the Mississippi River, is losing commerce and will continue to lose until such time as positively permanent wharves and landings can be provided.

The insecurity of wharves and landings and the constant changing of river banks further injure and depreciate the interests of a city, in that valuable and expensive improvements made in the interest of commerce, or for manufacturing purposes or residences, are in a few years rendered practically valueless, due to the changing of river banks, either engulfing them or vastly impairing their value by reason of their being no longer accessible to the benefits and advantages of the localities originally selected.

The interests of every city located on the Mississippi River demand that some measures be adopted whereby the banks of the river are rendered stable, and there is no question but that with the engineering knowledge now had of the subject and the skill and success which the profession has attained, satisfactory conditions can be secured. Hence the subject should receive the greatest possible consideration and study, and every measure thoroughly and exhaustively considered and investigated until the method having the requisite efficiency and economy is secured. The subject of maintaining permanent river banks has been considered for many years and commissions appointed by different cities, at different times, to canvass the matter, but no definite or satisfactory conclusion has been reached as to the proper method, due no doubt to the fact that in order to reach a conclusion very extensive study and experiment was necessary, requiring a very considerable amount of time and money, which not being available has rendered futile any effective or satisfactory results.

To the present time only two methods have received any reasonable amount of consideration or experiment: the spur dike and mattress work, adopted by the Mississippi River Commission twenty years ago and still being used by them notwithstanding the questionable success of the



WORK BEING DONE BY THE ORLEANS LEVEE BOARD

Along the Water Front of the Third Municipal District, City of New Orleans, Dec. 11, 1898.

work; and the pile bank protection work adopted and constructed by the Orleans Levee Board in the city of New Orleans under the recommendations and directions of the writer during the past three years.

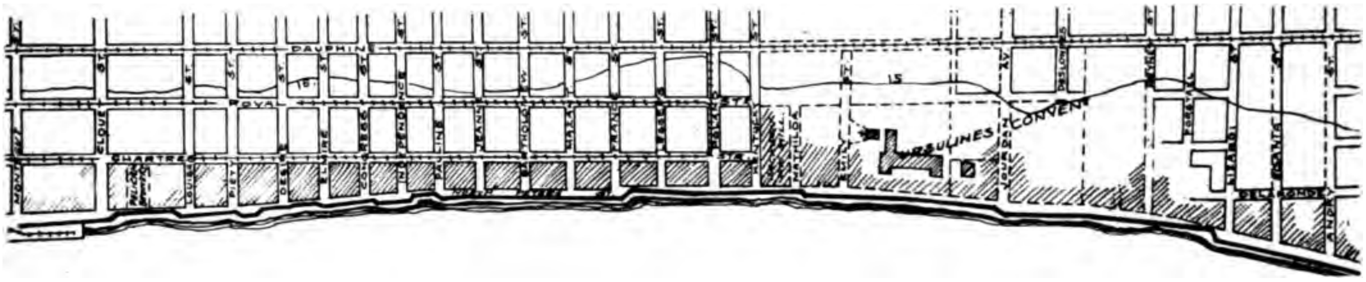
Before describing the relative merits of these two systems it is proper to analyze the cause of caving banks and the conditions existing which accelerate and hasten the caving and which require to be provided against to render effective any work having for its object the protection of river banks against abrasion.

The retardation of velocity of a flood river by a log, aggregation of floating material or other cause and which may be extremely small at the beginning, allowing the suspended material to be precipitated, inaugurates the forming of a bar or an accretioning bank, and these deposits which are being constantly precipitated soon aggregate a very considerable volume on the river bottom or on one of the banks, and naturally reduce the cross section of channel, which in turn increases momentarily the flood slope of the river and a momentarily accelerated velocity is produced, which, acting on lines of true laws of hydraulics, seeks and finds the line of least resistance and a new direction of current is formed setting towards the opposite shore to that where the accretioning in its incipiency is taking place. Thus the current is allowed to impinge directly against the bank, very lightly at first, but gradually increasing in intensity until the slope of bank is abraded and undermined and the serious caving of bank ensues, which action is accelerated by the increasing of depth of bend due to continued caving and the full force of current of river being thus deflected directly against the bank. If the bank against which the current is being gradually forced could be reinforced so as to have sufficient resistance to overcome the action of the current thus impinged against it and prevent its abrading the safe slope of bank, the current would scour out the deposits which were gradually forming and the proper cross section would be restored and consequently a stable channel would be secured.

It will be observed that the work required and expense entailed to reinforce a bank at the incipiency of its caving is very limited and small as compared with the intricate work required and the large cost entailed to hold a caving bank against further caving when the current has been allowed to be deflected directly against it. When not interfered with the whole volume of river will eventually impinge against the abrading bank at right angles, as is often observed, and which requires a change in direction of flow of the whole volume, which requires an additional head to overcome the losses in velocity caused by the friction of the whole volume against the bank, as also by the friction of the water on itself to turn a right angle. It will be further observed that when a bank has abraded so as to practically change the direction of current of the whole river the action of the current against the bank is so varied in its intensity throughout the stretch which is caving that the contour of bank becomes very irregular, due to formation of currents, cross currents and eddies, and that at near the lower end of an abrading bank, or where the current is forced to take another direction, whirlpools are formed, having immense power and scour very deep and at a point adjacent to the bank, thus making the slope of bank very steep. If unmolested these whirlpools gradually set farther in towards the bank and constant disastrous caving is occasioned.

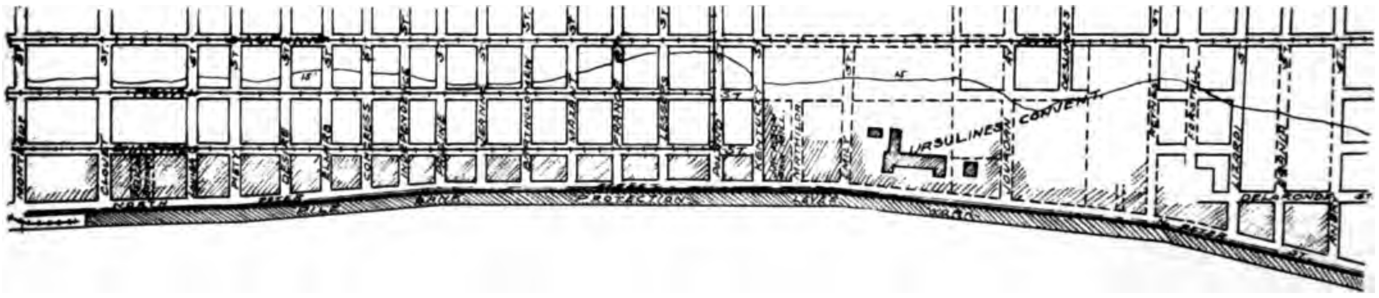
As above observed, to prevent the abrading of river bank where the caving is in its incipiency, or where the current is just beginning to be forced over against the bank, very limited measures and small expense is required to force the current back to its old channel and prevent any caving whatever of the bank.

Any measures having for their object the preservation of a caving bank, or a bank against which the current is impinging with abrading force, from further caving that do not provide a uniform impingement throughout the stretch where the caving bank exists for the current to strike against and thus remove the irregularities in the current, such as counter currents, cross currents, eddies and whirlpools, cannot be a permanent success. On the other hand, if measures on these lines are adopted whereby the current can be guided past the abrading bank at a uniform velocity the structure required to accomplish this end would necessarily have to be of such a character as to impede the velocity and allow deposits to form, and gradually any desired extension could be made riverward throughout the stretch of caving bank, as such a structure would provide a resistance more than

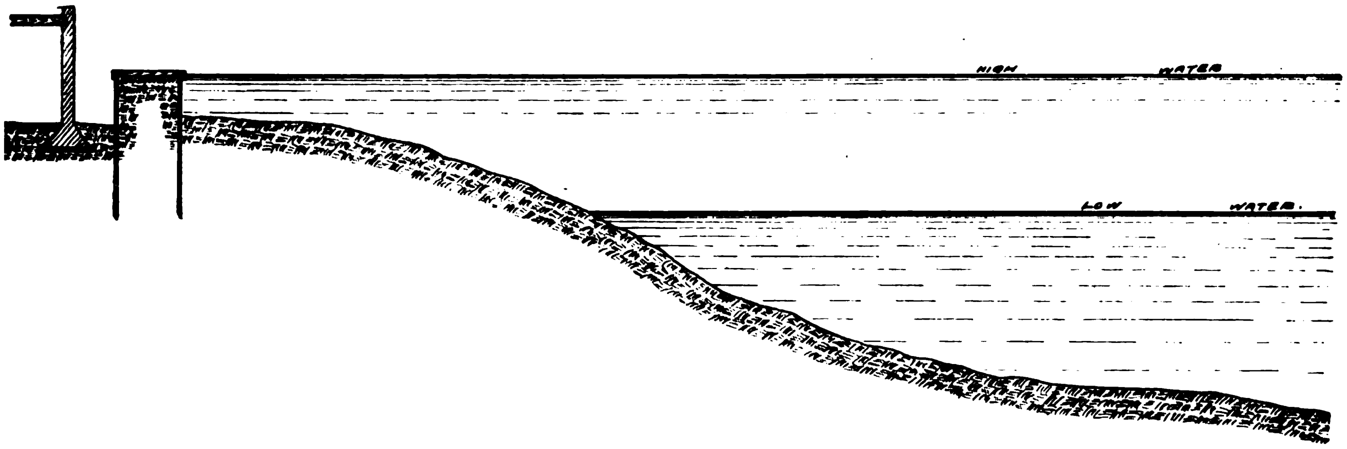


Location of Box Levees on North Peters Street in 1897, entirely closing same along Third District Front, before Pile Bank Protection was started.

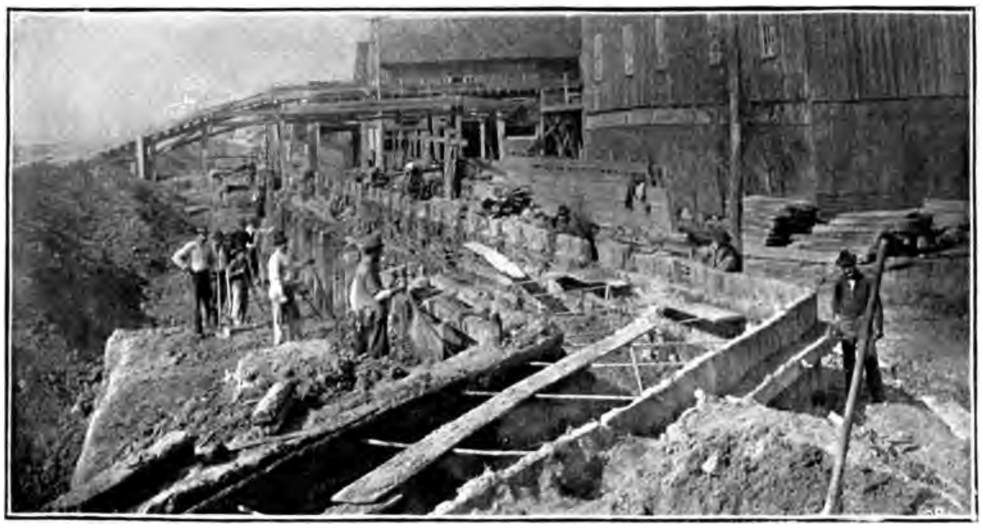
Moving Levee Riverward and Opening Street, Third District.



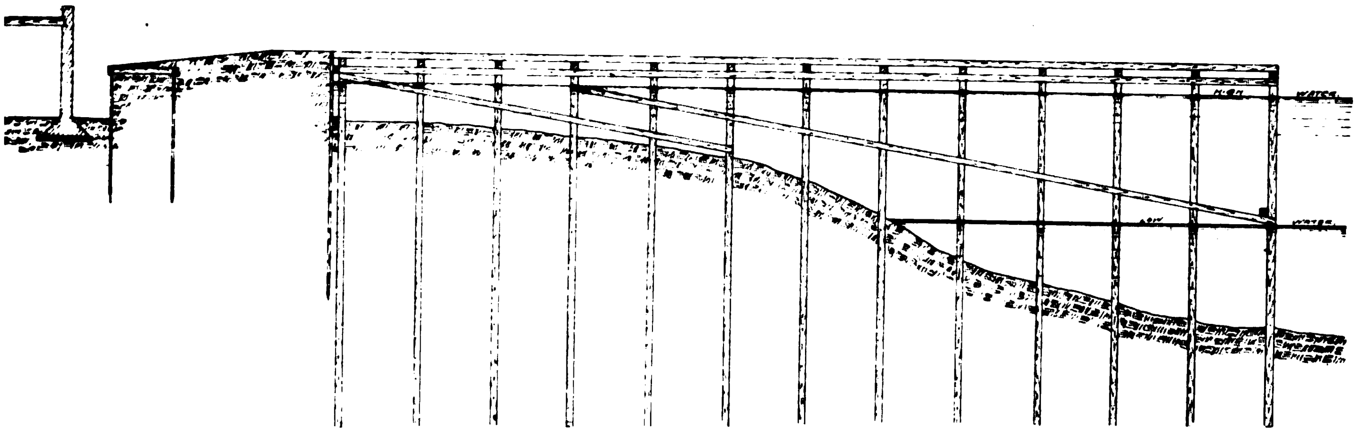
Showing location of Pile Bank Protection Work, as inaugurated in 1897, moving Levee forward, opening North Peters Street, saving of the properties and enhancing the value in squares which would have been destroyed if Levees had been placed on Chartres Street, as contemplated in 1897.



Location of Mud Box and Foreshore, as existing prior to inauguration of the Pile Bank Protection Work.



Removing Mud Box built in 1896, building Earth Levee riverward and opening Peters Street, Third District, New Orleans.



Pile Bank Protection Work in Third District, as now existing.

consequence the current often abrades the bank behind them and the mattresses and bank all cave into the river. Again, the mattress work, as any other protection work should do to be successful, must begin at a point where the abrading bank begins and be laid continuously. Again, even if the mattresses are laid on a uniform contour and are laid continuously from the upper end of an abrading bank and are extended sufficiently high for the surface flow of a flood river to impinge against same, they do not admit of any extension of a concave bank which is necessary in order to render gradually less intense the force of the current against any structure which may be placed and to gradually eliminate altogether the necessity of any structure other than the new natural bank which will be eventually formed.

The absolute failure of mattress work to protect abrading banks has been very thoroughly and positively demonstrated. Mattresses were placed and replaced between the years 1875 and 1882, at between Marigny and Spain streets, but no cessation of the abrading of bank and caving of the pier head wharves was caused until 1892, when a continuous wharf was built, and no abrading of bank or caving of wharves has occurred since.

Spur dikes and mattresses were placed in the third district bend between the years 1886 and 1893, but no cessation of caving was occasioned; in fact it is not certain but that they accelerated the abrading and caving of bank, which continued very rapidly until 1897, when the line of protection was a mud box placed directly against the highly improved property, annihilating the former paved Front street and batture, and when in 1897 the concensus of engineering opinion was to destroy the highly improved property and construct a levee 300 feet back; and with such results of what value was the spur dike and mattresses as a bank protection? As a matter of fact, the river bank in 1897 was 75 to 100 feet further inshore than when the mattresses were laid, hence, where were the mattresses in 1897? Figures 1 and 2 show position of two of these mattresses in third district in 1898.

Has the mattress placed at Gouldsboro been of any value when in 1898 a cave occurred directly behind the work, engulfing the mattress, necessitating the building of a new levee and the abandonment of a large tract of ground? Figure 3 shows the extent of caving at the Gouldsboro mattress in 1898.

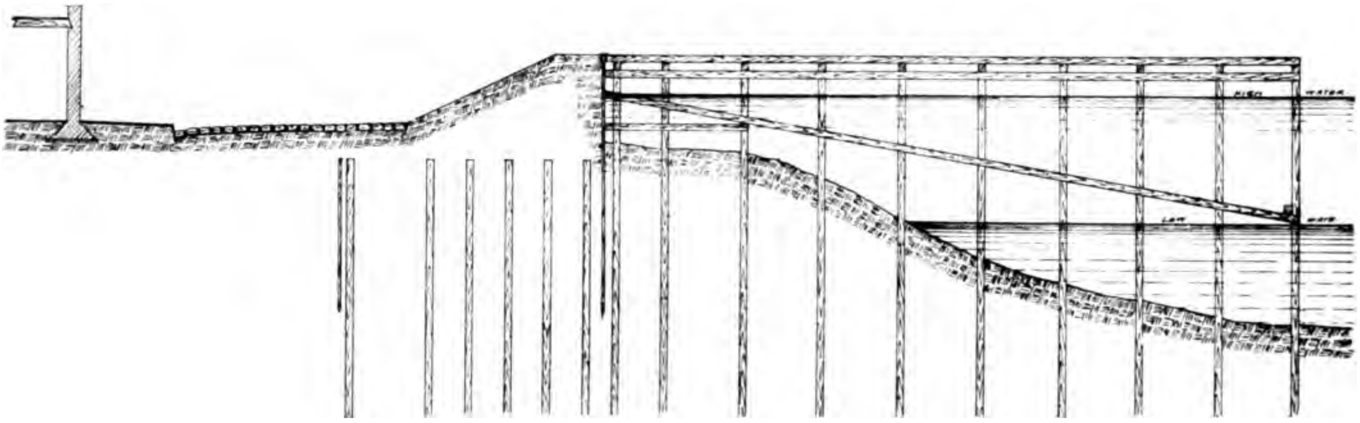
I would also refer to the recent caving of the bank at Southport, where mattresses and spur dikes had been placed at very large cost, and where the caving in September, 1900, directly behind the location of the work, has been of such large extent as to necessitate the immediate construction of a new levee to protect against inundation, and to render insecure the extensive wharf and elevator improvements owned by the Yazoo & Mississippi Valley R. R. Co. In fact the levee now being built places all these improvements and a large tract of valuable ground on the river side of levee.

In fact, is an instance recorded where mattresses and spur dikes have rendered unnecessary the moving back of levee?

Directly after the extraordinary high water of March and April, 1897, the Orleans Levee Board was confronted with extremely serious conditions of levees in third district of the city. For nearly a mile the protection of the city against inundation consisted of a box levee 8 feet wide, placed directly against highly improved manufacturing and residence property, and the river bank had abraded to such extent that these mud boxes were located directly on the brink of the river. This rapid abrasion of the bank occurred notwithstanding the fact that the United States Government had placed throughout this stretch very extensive work of the spur dike and mattress type; as a matter of fact they were engaged in this work for several years.

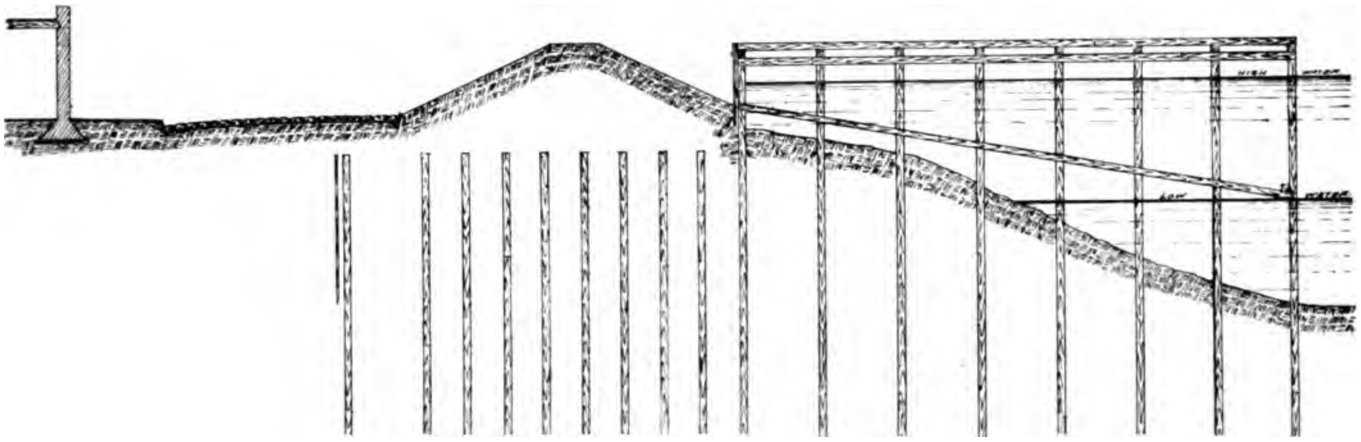
The situation at this time, 1897, was such that extraordinary drastic measures had to be adopted. The concensus of opinion amongst all the engineers, Federal, State and city, in fact their recommendations were that a new levee be constructed in rear of the existing mud box levees throughout the stretch; and their recommendations were most strenuously urged by the press and otherwise notwithstanding the fact that such a measure would necessitate the destruction of a very large amount of valuable manufacturing and residence property, and would annihilate several important manufacturing industries which gave employment, in the aggregate, to some 400 and 500 hands. The Orleans Levee Board was extremely loath to destroy this valuable property, and after a very thorough consideration of the matter, and in opposition to public opinion as delineated by the press, they determined to attempt to hold the then existing line of levee by bank protection work, and the methods recommended by the writer were

Two Views of work done by the Orleans Levee Board, protecting New Orleans Harbor. Photographs by Mississippi River Commission.



[Note.—Engraving does not show full relative depth of Piles.—*Ed.*]

Pile Bank Protection Work in Third District, showing proposed work of New Levee Revetment, placing same on Piles and opening North Peters Street.



[Note.—Engraving does not show full relative depth of Piles.—*Ed.*]

Pile Bank Protection Work in Third District, showing ultimate plan of work, with River Slope to Levee, provided Commerce does not utilize the front and material woodwork.

adopted and work inaugurated at once. Figure 4 shows the position of the levees as they existed throughout this stretch in 1897 and the hetched squares which are highly improved and which were to be destroyed if levee was moved back. Figure 5 shows the position of protection work and levee, and street opened, as contemplated by the method adopted in 1897.

Figure 6 is a cross section showing the relative position of the box levee, river bank and improved property as existed in 1897.

The method which was adopted and which I will term "Pile Bank Protection Work," embraces three stages, each stage to be executed at such time as conditions determine.

The first stage is shown by Figure 7 and embraces the driving of piles throughout the stretch 70 to 80 feet long, at a uniform distance apart and the work extending into the river to such line as will best receive and guide the current past the abrading stretch, the whole work being very thoroughly braced and secured together. The piles of bulkhead row being spaced closer together and supporting a water-tight sheet pile bulk-head, forming support for levee of increased dimensions over that of the mud box as shown.

The results of the work were highly satisfactory, the banks not only ceased to abrade, but actually accretioned, and the slope of bank was materially improved, which improvement as determined by soundings recently made, is still continuing.

The conditions of the bank throughout the stretch were in such condition in 1899 that the second stage of the work was inaugurated. This stage is shown by Figure 8, and consists of the annihilating of old mud box, driving of new bulkhead on river side of the one driven in 1897, and the placing of a strong substantial earth levee on the river side of Front street, directly into the river as it existed in 1897, and the opening up and regaining use of street. It will be observed that the piles driven in 1897, which were located in line of levee were cut off below street surface and additional piles driven and the levee placed on these piles and supported thereby, the same as a building, which transmits the weight of levee to a plane on line near bottom of river and relieves the batture and bank of the weight of levee.

Figures 7 and 8 show the moving of levee riverward in course of execution.

The third or last stage, as shown by Figure 9, contemplates the placing of a river slope of earth on the levee as constructed during second stage and supporting same on piles and is to be undertaken at such time as desired, it being the intention to execute this work when the bulk-head in front has deteriorated to such extent as to require renewal, and after this river slope is completed to protect the earth by a light wave wash revetment in front as shown in Figure 9.

The conditions secured by Pile Bank Protection Work are that the work extends continuously from the upper end of an abrading bank sufficiently far into the bend to throw the current from the shore; that it extends above highest flood line and sufficiently far into the river to affect 30 or 40 feet of the body of a high river; that the piles are placed at a uniform distance apart and provide a uniform obstruction to current striking same; that the front or river line of work is placed to such line as to best receive and guide the current past the work; and the theory of the success of the work is that the flow of river for a depth of 30 or 40 feet is guided past the abrading bank at a safe and uniform velocity by being allowed to impinge against the piles placed at a uniform distance apart and on such a line as to assist the deflection of current from bank, and which obliterates the cross currents, counter currents and whirlpools, and checks the velocity of whole river sufficiently to form a gradual improvement of the bank of river, limiting the extent of movement of bed of river towards the opposite bank only by the gradual extension of the Pile Bank Protection Work into the river; all of which is in line with nature's laws, in that the method adopted provides the line of least resistance on the side or at the point where under unmolested conditions the line of greatest resistance existed, and securing satisfactory results by the utilization of the same forces which previously acted to the detriment of all interests.

In comparing the results of the two plans which have been studied and experimented with, it does not follow that either of the plans embrace all the requisite qualities for bank protection, and as can be seen the subject is a most exhaustive and important one, and there is no doubt but a continuous and careful consideration of the subject will develop methods which will embrace the necessary economy and efficiency, and that the Mississippi River Commission can be harnessed and bridled so as to obey with absolute certainty the course which man shall dictate.

F. M. NORFLEET

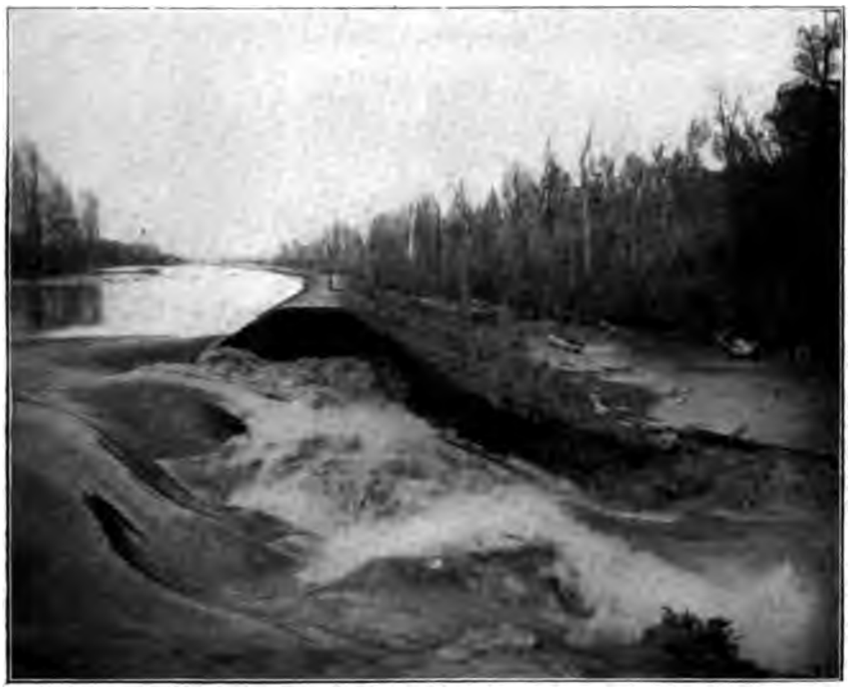
A CREVASSE ON THE MISSISSIPPI RIVER

BY F. M. NORFLEET

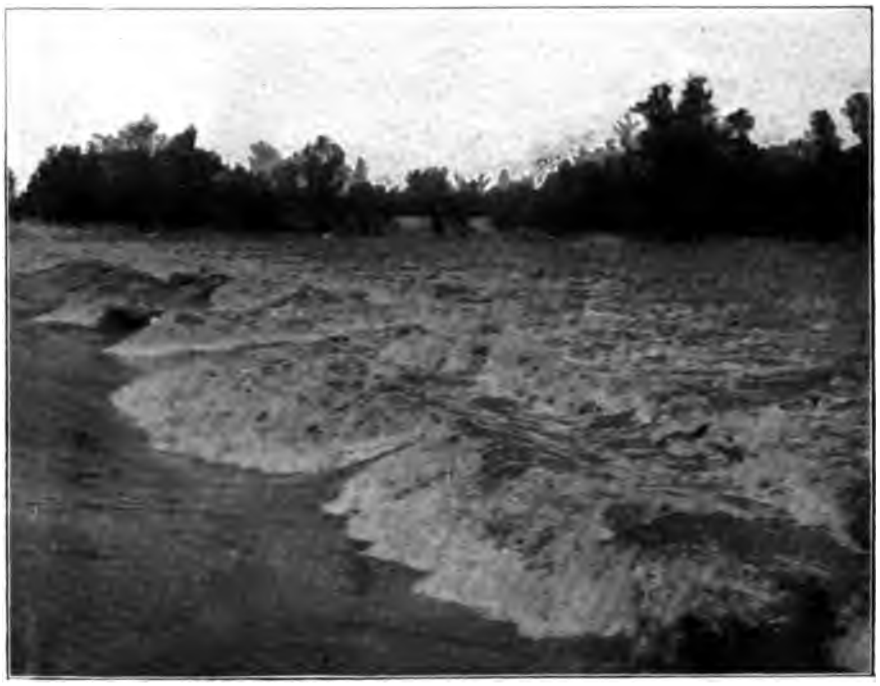
When, early in March, the river had reached danger stage at Cairo, and the main tributaries were pouring in such additional volumes, I began to feel uneasy for the safety of the levee system along the Yazoo front, and especially that line fronting my planting interests on the south bank of Flower Lake, in Tunica County, Mississippi.

I decided to make a personal examination, and to aid in making a strenuous fight to hold the levees. On my arrival there, I found 4 or 5 miles of levee which was below the general grade, and at a very exposed place where the line of levee was running almost due east and west, and directly opposed to the current of the Mississippi River. The gravity of the situation impressed me, and a meeting of the citizens was held to discuss the best course to pursue. We began to raise the levee at once under the management of Capt. T. C. Ferguson, one of the Levee District Commissioners, with the best forces which we could muster. It soon became apparent that we had started too late, and with resources too meager for so large an undertaking. The chief engineer, and other officials of the Yazoo Levee Board, were engaged in a tremendous fight to hold the levee line at Green Grove, in Coahoma County, and all the power of the official organization was utilized and almost exhausted in holding that point. This was successfully accomplished, finally, owing probably to the break in the levee on the Arkansas side, which allowed the crest of the great rise to flow off through the White River basin.

The energies of the Levee Board were then turned toward getting men and material to aid us on the Flower Lake front, which was placed under the control of Capt. A. L. Dabney, but, as stated above, it was too late—Grant and his army could hardly have saved the day then. The land back of, and along the line of, the levees had become so thoroughly saturated with seep water, that dirt could no longer be had to fill sacks, nor for wheelbarrows. It was evident that the great river would break through the feeble barriers which we interposed to stay its ravages, and, although we had piled sacks of earth on top of the levee four and five deep, and backed them up with dirt for miles, we could see the rushing floods might well laugh at our puny efforts, and that we had not planned by half what was necessary. Preparations now must be made for the inevitable! On Saturday afternoon, April 3, I told the heads of families living on my place to discontinue work on the levee (we had considerable outside help by this time), and to arrange to protect their families and save their household effects and livestock. We had already built an inclosure adjoining a strong piece of levee, and had corraled all the livestock on the place so that in case of a levee break, it would only be necessary to open a gate and drive them over this protection levee, where they would be safe. Naturally, I felt a great responsibility for the lives of about 200 women and children on my place who were in the darkness of the night, amid the most terrific rain and wind storms, and peals of thunder which shook the very earth itself, sleeping in their beds from 6 to 10 feet below the surface of the water, which for miles in their front was being held back by a levee soaked through and through, and leaking in myriads of places, and trickling over the tops here, there, and everywhere. I was apprehensive that this great menacing wall of water might break through in the darkness of the night like a Niagara and carry death and destruction in its path. I could not sleep. I have been in front of the cannon's mouth, and have heard the rattle of musketry and the whistling of bullets, but I had never felt such an awful dread before. If the crash could have come earlier, before the water had been dammed to such a great height, the danger would have been less, but the long-drawn-out fight and higher water intensified the expected calamity. I sat in a chair all that night in a drizzling rain on the levee, with a dozen barefoot negro boys to patrol the levee with lanterns to see if the water was com-



BEGINNING OF A CREVASSE

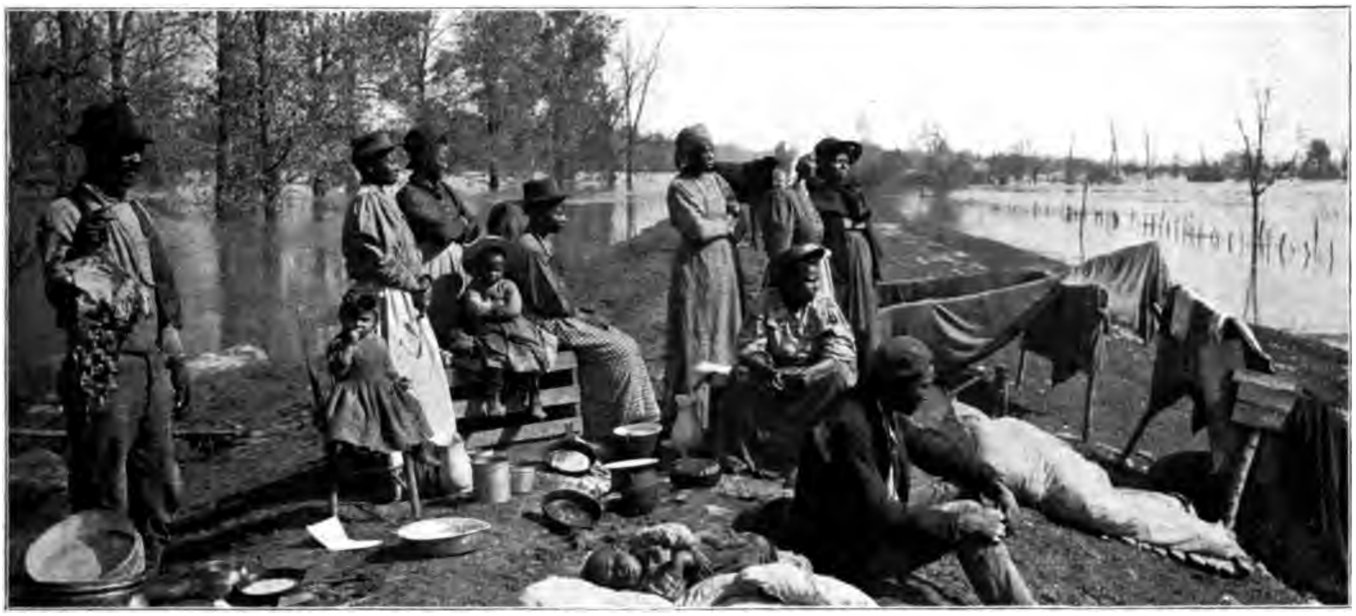


CREVASSE AT ITS MAXIMUM

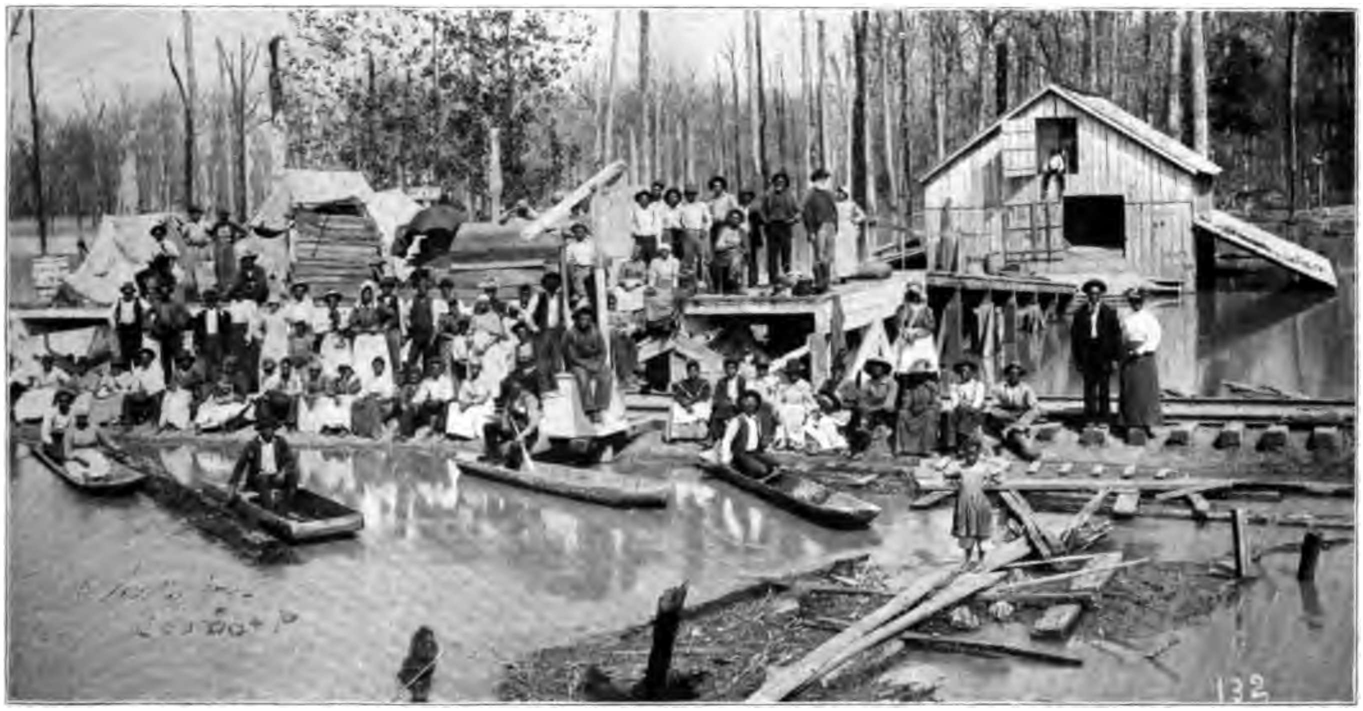
ing through—to detect signs of immediate danger (a man with shoes on could not stand or walk on the levees at night). When daylight came—that beautiful Sunday morning—I could see the progress the river had made during that awful long night. I saw at once that all hope was gone—that it would be impossible to hold the levee until noon. I went to plantation headquarters and notified the manager that all was over, and that he could prepare for the worst. Old Sol was then rising—clear and beautiful—for the first time in days. He seemed to have his face unveiled to see, without hindrance, the fearful crash of water that in the next few hours would break through the artificial barriers that staid their way, and cover the homes and lands of thousands of people with its engulfing waves. I tried to compose myself for a short sleep, but it was impossible. The danger and the excitement of the moment had caused sleep to vanish from my eyes. Accompanied by Mr. T. H. McKenzie, of Lulu, Miss., we mounted our horses and went back to see if anything more could be done. On reaching the levee I found a squad of negroes and whites that had been instructed to take the place of the night force, still in camp waiting for breakfast, the hopelessness of the situation making demoralization complete. Mr. McKenzie went ahead down the levee to see if any dangerous places had developed in the last two hours. He had gone but a short distance when I heard him halloo, "Bring 25 men with shovels and sacks—quick!" We ran to the point from which he had called. I could see the waters breaking through the levee about one-third of the way down from the top—it was a high levee at this point—in a stream 3 or 4 inches in diameter, and before getting to where Mr. McKenzie stood it was the size of a stove-pipe, and in less than a minute of a water bucket, then a barrel, and before you could describe it, the whole top of the levee was twisting in, and the water was forcing itself through in a great torrent, and striking the ground beyond the base of the levee with terrific force, rebounding in awful anger, white waves 20 feet high tearing great oak and gum trees out by the roots, and tossing them about as if they were cork. The ends of the levee began to erode very rapidly above and below the break, until over 15 acres were torn out like a great well, with holes and pits, some of them 50 feet deep. The rushing, swirling, tumbling waters made a sight of wondrous grandeur and appalling solemnity. The caving became more gradual until the break was about a half mile wide. But the great tension was over, and we turned our thoughts to getting the families out of danger, and preventing other breaks taking place before relief came from the fall in the river caused by this break.

All during this levee fight, and after the crevasse occurred, I was getting valuable and practical experience that can be made useful in the future. This is a description of the greatest crevasse that ever occurred on the banks of the greatest river in the world. The result of my observation is that there is not half the danger to life and personal property in being located behind a great levee when the break occurs as one would suppose. For instance, it was quite six hours before the water covered my place, and just to the extent that the water raised on the land side, the level was lowered on the river side, so that by the time there was an average depth of 4 feet on the land, the river had fallen 4 feet, and the water never attained anything like the depth that one would naturally suppose it would, as it was piled up from 10 to 20 feet above the height of the land against the levees. All the people on my place and adjoining places had ample time to get away to elevations of safety. There were about four or five tenant houses, which, being in the main track of the current, were washed away, but, as stated, the occupants had plenty of time to move out. If the break had occurred at night there might have been some loss of life, but it is hardly probable. The rapid fall of the river after the break relieved the levee line above and below, so that it dried out quickly, and afforded a safe place to all whose homes were overflowed by the waters.

The next practical lesson I learned was that as soon as fears are entertained for the strength of a levee, it is the part of wisdom to commence with all resources at hand at once, and spare no expense in strengthening weak places that may be known to exist. This can be done while the dirt along the levee is dry, and at from one-half to one-tenth the cost at which it must be done at the last moment. It will not suffice to begin with plantation hands in small squads to strengthen the levee in time of emergency. To accomplish anything there must be well organized camps with ample bedding and cooking outfits, also proper tools, run planks,



SAFE ON THE LEVEE—BREAKFAST SCENE DURING FLOOD OF 1897



BOAT RACE IN THE OVERFLOW—SCENE DURING THE FLOOD OF 1897 etc., on the ground in good time, and these outfits should be kept on hand, or arranged for by our levee boards so as to have them always ready. There is no class of work on the earth that the old adage, "Not to put off until to-morrow what can be done to-day," applies with more force. A half levee in the time of extremely high water is far worse than no levee at all, and there should be no cessation by any levee board until the entire line is brought to its maximum height and width, if it is possible by any means to get funds to complete the work.

A great part of our levees are below their ultimate dimensions, and it is hoped that with larger appropriations, and with more active work for the next four or five years, these will be raised above the danger of recurring floods. There may be before this time many more breaks in the levees, but the consensus of opinion among all practical levee men is that such a thing as a general overflow is hardly possible. More money and more dirt means more safety and more development, and we are putting great faith and great hopes in the action of the General Government.

Jno H. Bryant.

THE MISSISSIPPI RIVER FROM CAIRO TO NEW ORLEANS AND FROM NEW ORLEANS TO THE GULF, 1072 MILES

COMPILED BY JNO. W. BRYANT, OF NEW ORLEANS,
FROM SUCH RECORDS AS WERE OBTAINABLE AT THE CITIES ALONG THE RIVER

Commercial Statistics—Statement Showing the Number of Vessels, Steam and Unrigged, Tonnage, the Transportation of Freights and the Values of Vessels and Commodities, for the Year from June 1, 1898, to May 31, 1899

The census of 1890 divided the waterways of the Mississippi Valley into three rivers of origin—the Ohio, the Upper Mississippi, and the Lower Mississippi. The Lower Mississippi was made to begin at St. Louis. From that city, and inclusive of the tributaries, the Lower Mississippi mileage of waterways was given as comprising 6,228 miles, of which 5,695 miles was being navigated in 1890.

The 1890 census report gives the total of commerce originating on the Lower Mississippi as follows, to-wit: Wheat, 528,800 tons; corn, 698,545 tons; other grain, 57,861 tons; cotton, 865,228 tons; cotton-seed and cotton-oil products, 392,988 tons; sugar, 131,948 tons; coal, 360,799 tons; a total of 3,036,169 tons. That included the river from St. Louis down. Another exhibit gave the tonnage as follows, viz.: Lower Mississippi, 4,374,671 tons; White River, 86,398 tons; Arkansas River, 1,663,817 tons; Yazoo River, 77,380 tons; Ouachita River, 93,707 tons; Red River, 105,145 tons; a grand total of 6,401,203 tons.

Just how 865,228 tons cotton, equal (at 500 pounds to the bale) to 3,460,912 bales, is made to originate on the Lower Mississippi River is not shown in the exhibits, and is not easy to understand in view of another exhibit in the same report, which gives the total product of the cotton crop of Missouri, Illinois, Kentucky, Tennessee, Arkansas, Mississippi and Louisiana, the seven states bordering the Lower Mississippi, as amounting to a total of 678,176 tons, or 2,712,707 bales.

The statement prepared at this time, as stated above, embraces the river south of Cairo, inclusive of the tributaries, and is a showing of the tonnage and commerce not only originating but actually passing on the rivers, and for the period mentioned.

VESSELS

Mississippi River.....	Number Vessels.....	Net Registered Tonnage — Tons.....	No. trips made —Total.....	Total Amount Tonnage — Tons.....	Total Value.....
Steam's	189	62,314	6,212	1,590,004	$4,331,000
Barges..	1,635	1,408,814	2,470	2,082,260	2,003,000
Total...	1,824	1,471,128	8,682	3,672,264	$6,334,000
Tributaries. Steam's. Local Total .	61	3,193			
Entr'ces N. O. C'st'm House. Total .	1,324	1,928,061			
Grand Total .	3,209	3,402,068			

The above exhibit does not include vessels, steam or otherwise, engaged in harbor work exclusively, nor ferry or railroad transfer boats. Nor does it include the various vessels owned and employed in the Government service.

COMMERCE

Between Cairo and New Orleans—	
Total number of tons carried—tons.	4,708,355
Total value	$94,605,762
Between New Orleans and the Gulf—	
Total coastwise and foreign—tons..	2,985,643
Total value	$144,704,136
Grand total between Cairo and the Gulf—tons	7,693,998
Grand total value	$239,309,898

COMMODITIES

The chief commodities moved by vessels, between Cairo and New Orleans, exclusive of the local traffic in the tributaries, may be enumerated as follows, viz.:

Cotton—bales	612,242
Cottonseed—tons	166,049
Sugar and molasses—tons	153,664
Lumber and logs—feet	444,539,180

It is nearly impossible to prepare a complete statement of the river's tonnage and commerce unless in the examination of the books on every boat. That requires opportunity and time, for, as it is now, always was, and ever will be, the steamboats, all of them, are not under corporate control. There are lines of boats, but wherever the line, as where the line is not, there are individually owned and independently operated steamboats, which are in one place one time, and somewhere else at another time. Because of this, and because of the necessity of going for the data to each and every boat wherever they might be, which was not done in this instance, a full table of the statistics has not been given. They call for only what was obtainable, and the record of no boat not visited has been computed.

Some sixteen or seventeen years ago, the writer of this prepared for the use of the Mississippi River Commission, a two years' exhibit of the river's commerce into New Orleans from above, and also one covering the two years just preceding the completion of the Eads Jetties (South Pass), Mississippi River. This was about the time of the passing of the "river palaces" still so much written about by mossback pessimists, who apparently do not know of there being more tonnage on the rivers to-day than then, and it was coincident with the development of the railroads across and paralleling the river; the comparison showed a diversion of about one-third of the river business. The census report of 1890, admitted by the Commissioner to be incomplete in the returns from the carriers by water, showed over fifty per cent of all of the commerce of the country carried by water. Some five years ago statistics of the river were prepared in the interest of a corporation proposing to build a bridge across the Mississippi River somewhere above New Orleans, and it was so used, but it showed a diversion of thirty-five per cent only. Of course it will be understood that the railroads were carrying more than that thirty-five per cent, for as has been said, "The waterway creates traffic for "the railroad as well as itself, makes raw materials "cheaper, increases the number that are available "for use, and adds to the products of agriculture "and manufacture seeking transportation."

A president of one of the great railroad systems paralleling the Mississippi River is quoted as having said: "Coal, iron, steel, and other freights "should be carried by water, for the building up of "manufacturing industries by this means among "the towns and cities along the river would give "larger traffic to the railroads in more profitable "lighter freight." The moral of which is, maybe, that otherwise coal, iron, steel, etc., would come higher.

Three years ago an eminent civil engineer, whose interests, public and private, at the time were deep in the plans for the building of another bridge over the Mississippi, said before a Congressional committee: "The railroad business is rapidly and "largely increasing, and that of the river decreas- "ing." Now, he was plainly exalting the one and belittling the other, but his facts and figures were not so much in evidence as the location of some of the bridge piers he had planned, two of which, at least, have wrought destruction to life and property, and to an extent sufficient of itself to have served as a warning against the continued building of low, narrow-spanned and faultily-located bridges. In truth, it is only just such bridges which are opposed by rivermen, who firmly believe that if the departments of the Government were as zealous and exacting in the care of the commerce passing under these bridges, as they are considerate of the objections of greater cost always raised against the higher, wider-spanned

CAPT. WM. CAMPBELL

CAPT. CHAS. W. DROWN

CAPT. J. B. WOODS

CAPT. A. M. HALLIDAY

CAPT. CHAS P. TRUSLOW

CAPT. L. V. COOLEY

CAPT. E. J. COMEAUX

CAPT. W. L. DUKE

CAPT. C. S. KOUNS

CAPT. JAMES LEE
Founder of the Lee Line of Steamers

CAPT. J. W. CARLTON

CAPT. T. P. LEATHER

CAPT. GEO. W. REA

bridge, there would be fewer protests, and the probabilities of accidents reduced to a minimum. It has been the wonder that the authorities, while planning and spending millions for the improvement and preservation of navigation, yet permit of obstructions, and stranger still, should appear always so suspicious and unresponsive to the protests of the rivermen. The steamboats have but the one way to go, but a bridge may be built which neither hinders nor imperils.

A railroad president wrote: "The matter of "transportation is one of the most vital import to "all the people next to the cultivation of the soil. "* * * There is no question but that the "cheapest transportation which can be furnished "in any way is by a good steamboat and deep water "in which to run her."

This year 66,615 tons steel rails, nearly 3,500 carloads, were towed on barges all the way, 2,000 miles, from Pittsburg to New Orleans and there transferred to railroad cars. Would the railroads have refused the earnings of that long haul, particularly in the face of oft-repeated assertions that the long was cheaper than the short haul, unless, indeed, it was being carried the cheapest by river? Then, if water transportation is the cheapest, how can it be said that the steamboat is being displaced?

At this last session of Congress a committee of business men from the Ouachita valley appeared before the Rivers and Harbors Committee to endorse and urge a proposed plan for slackwater navigation. These gentlemen gave in evidence the fact that when the steamboats get to Camden cotton is shipped 700 miles to New Orleans at $1.25 per bale. When it has to go all-rail—475 miles—the rate is $3.10 per bale. Flour was 35 cents per barrel by steamboat, 75 cents on the railroad. Boots and shoes, all water from Boston, was 79 cents; all rail, $2.02. But these great differences in rates, they said, was enjoyable only during the navigable periods, after then the maximum rates maintain, and this applies to every other stream. It being an established principle in the economics of commerce that the speedier and easier the products of a section pass along the trade routes, the greater will be the return for the labor of the producer, and the further will go the purchase money of the consumer.

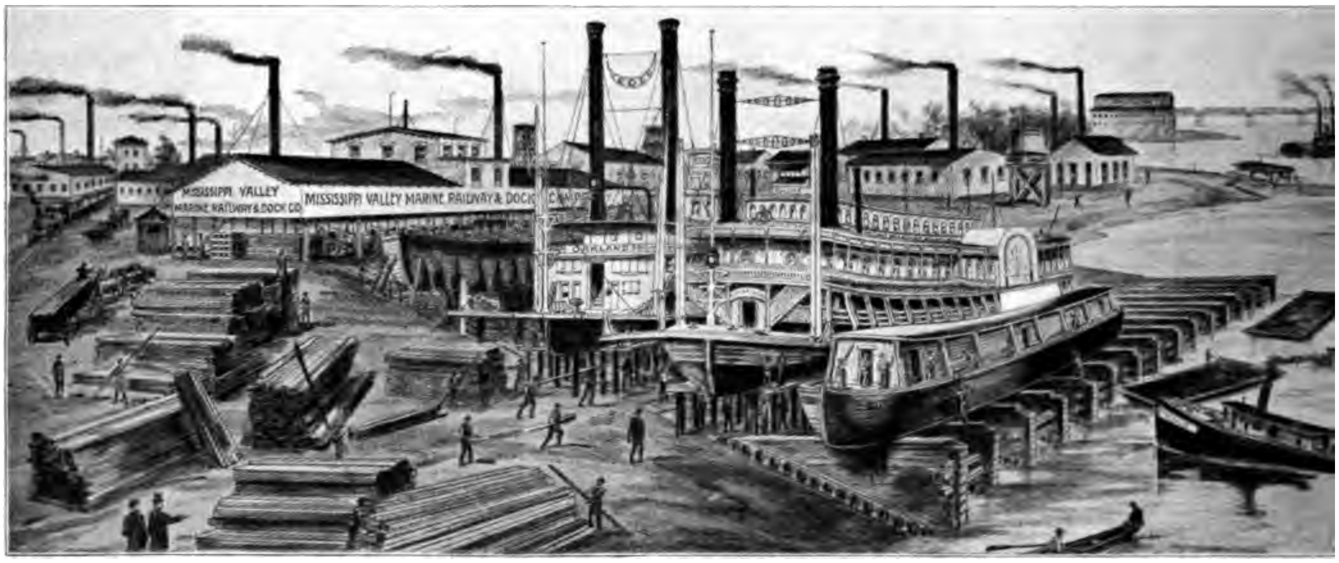
But this leads to the consideration of why has there been this diversion of the river's traffic? There are three principal reasons, one, interrupted navigation; another, railroad bridges; the third, federal and local legislation.

It is perhaps because river improvement does not always improve that rivers and harbors appropriations have been called a steal. The people of a locality petition for steamboat navigation, their Congressman advocates it, the United States engineer examines, estimates and recommends, Congress gives the money (never the full amount), and the United States engineer expends it. There is no steal there, nor is there preventable waste, for the rivermen know of no calling more honest and conscientious than that of the engineer, just as others know of, there not being a better informed, more conservative, business-like committee in any legislative body than the Rivers and Harbors Committee of Congress. Yet the truth is, there has not been realized the long-sought, greatly to be desired, satisfying results from the generous, as unquestionably wise, provisions of Congress, and the workings of the United States engineers, to unloose the fettered waterways and give greater impetus to its restricted commerce. Sand bars and snags still hinder and endanger navigation during the low-water season with discouraging regularity of recurrence, and for often the longest half of the year—almost always from July to November, the season of harvest. When steamboats have to stop altogether or pull and force themselves over bars and snags, to the bottom of the river or in dock, serious losses are incurred. In most of the tributaries there are the same impediments to safe continuous navigation, the same consequent excessive insurance (from 8 to 18 per cent), the same periods of enforced idleness which existed ten and twenty years ago, and their betterment is still nothing more than a promise.

In an article in the New York Nautical Gazette on the decline of the western river steamboat trade, it was written:

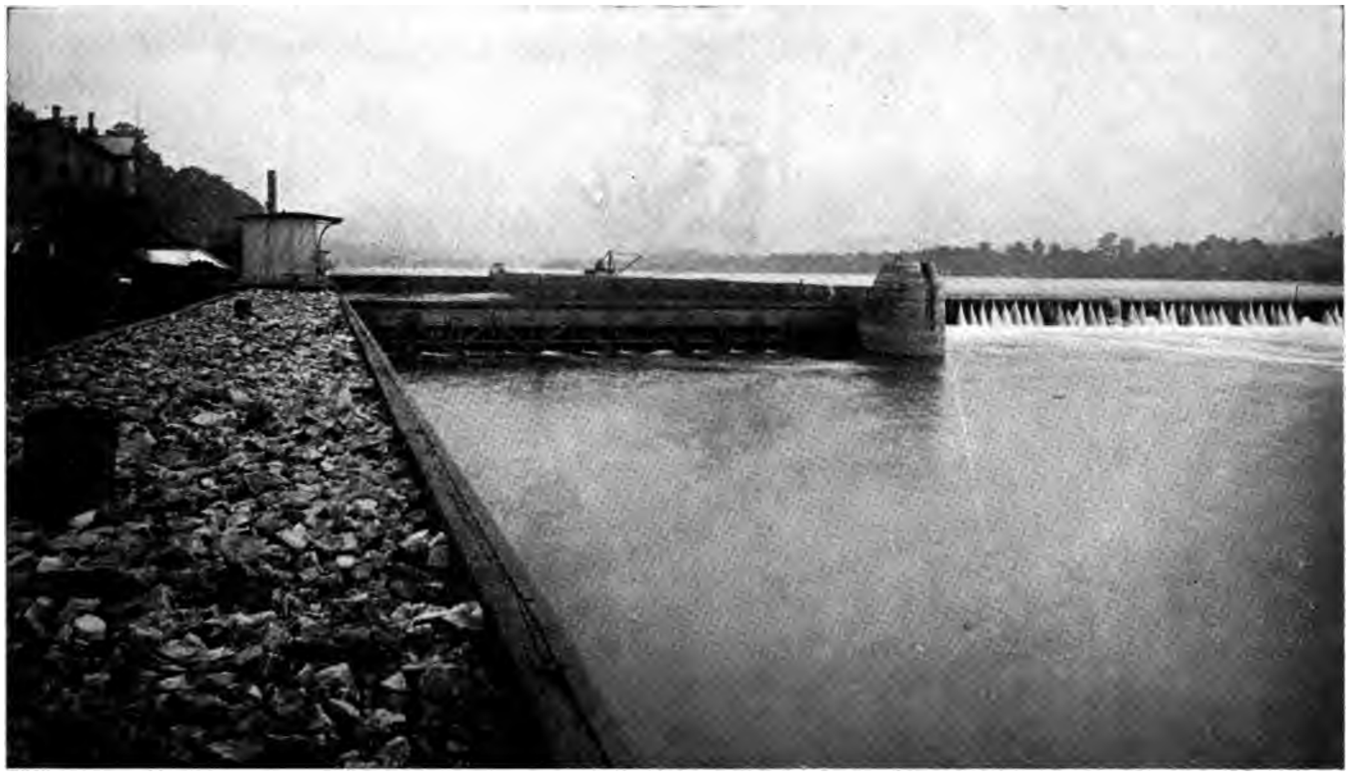
"On the Ohio the chief reason for the decline "in the volume of business done is caused solely "by reason of lack of water. * * * Navigation "is suspended the greater part of the time, and a "great fleet of boats is tied up, waiting for a rise in "the river. * * *

"It is a fact well known to all conversant with "navigation on the Ohio River that if there was

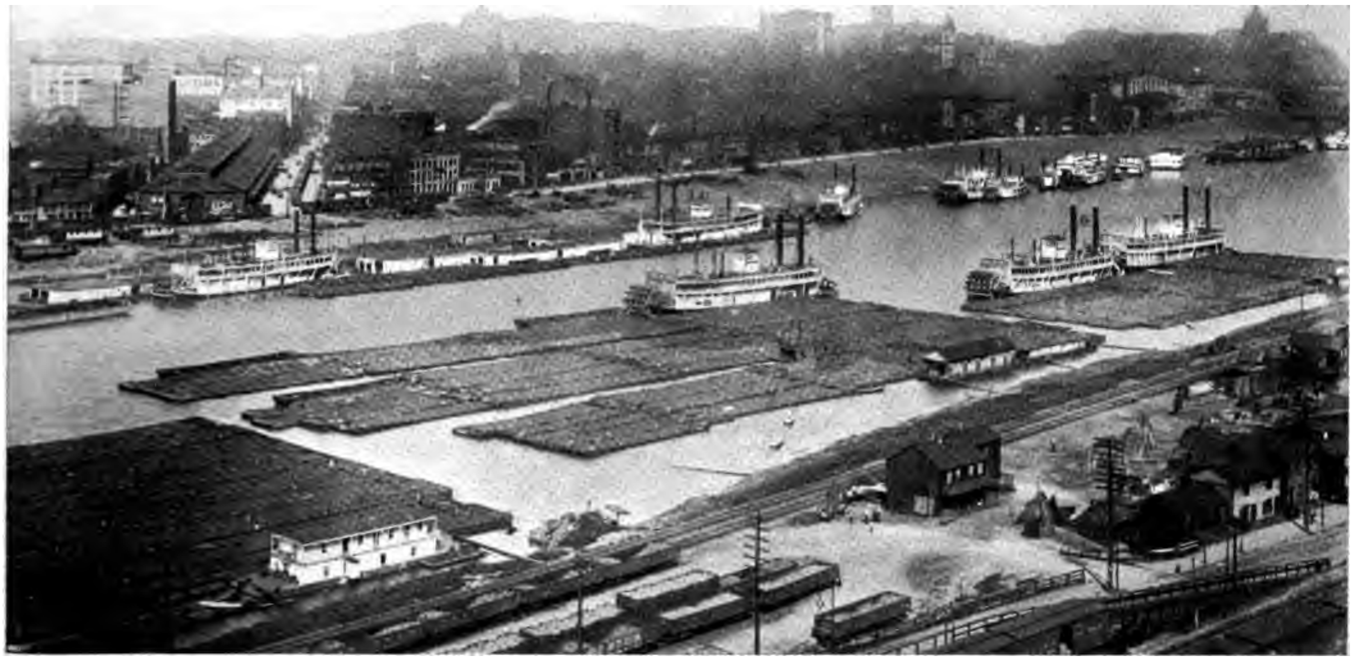

MISSISSIPPI VALLEY MARINE RAILWAY & DOCK CO.
MISSISSIPPI VALLEY MARINE RAILWAY & DOCK

MISSISSIPPI VALLEY MARINE RAILWAY AND DOCK COMPANY'S DOCK AT MOUND CITY, ILL.

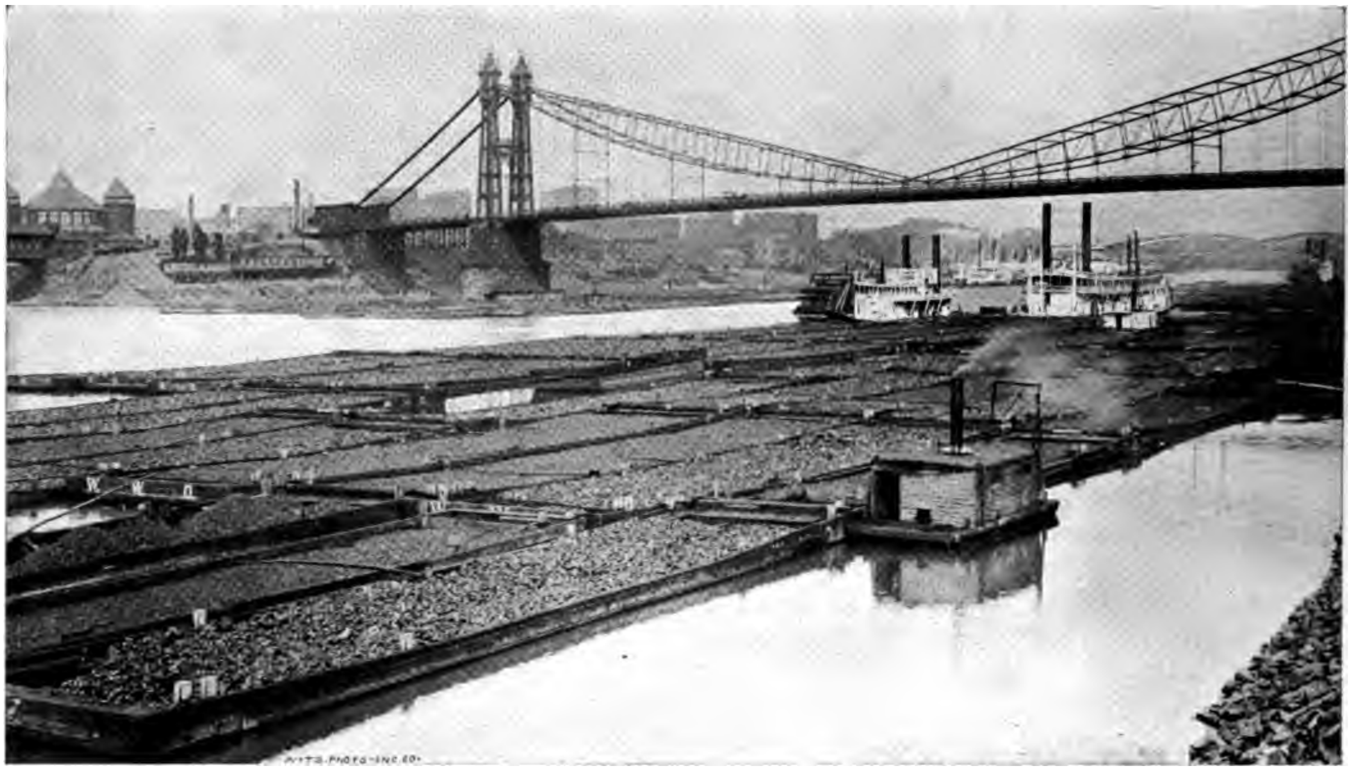
GOOD INTENT DRY DOCK, NEW ORLEANS, LA.



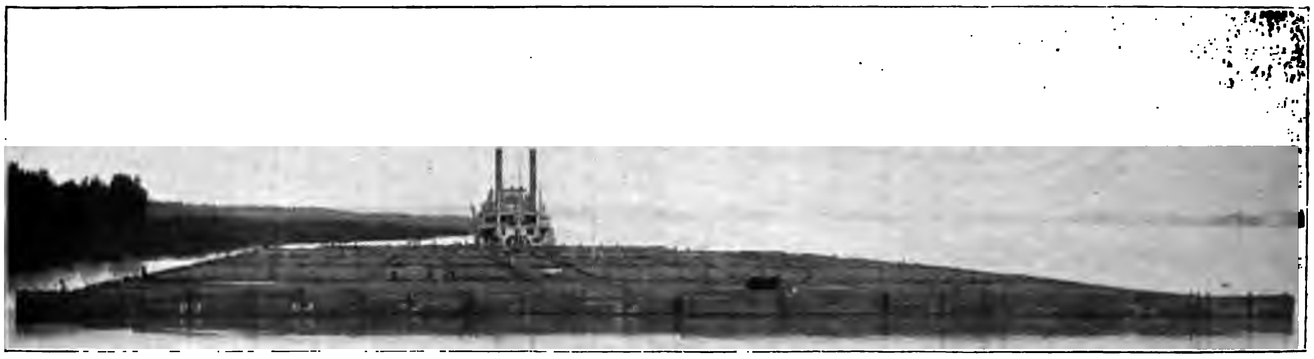
DAVIS ISLAND DAM—THE INITIAL POINT OF COAL SHIPMENTS FOR THE SOUTH



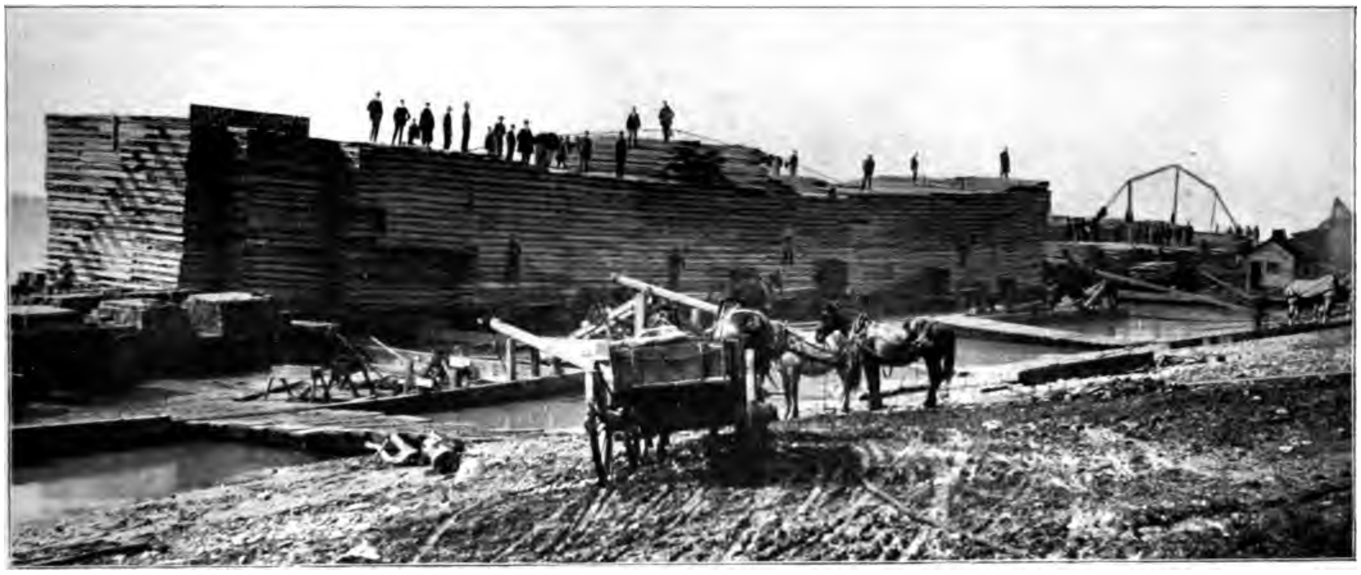
COAL IN PITTSBURG HARBOR WAITING FOR A RISE IN THE RIVER



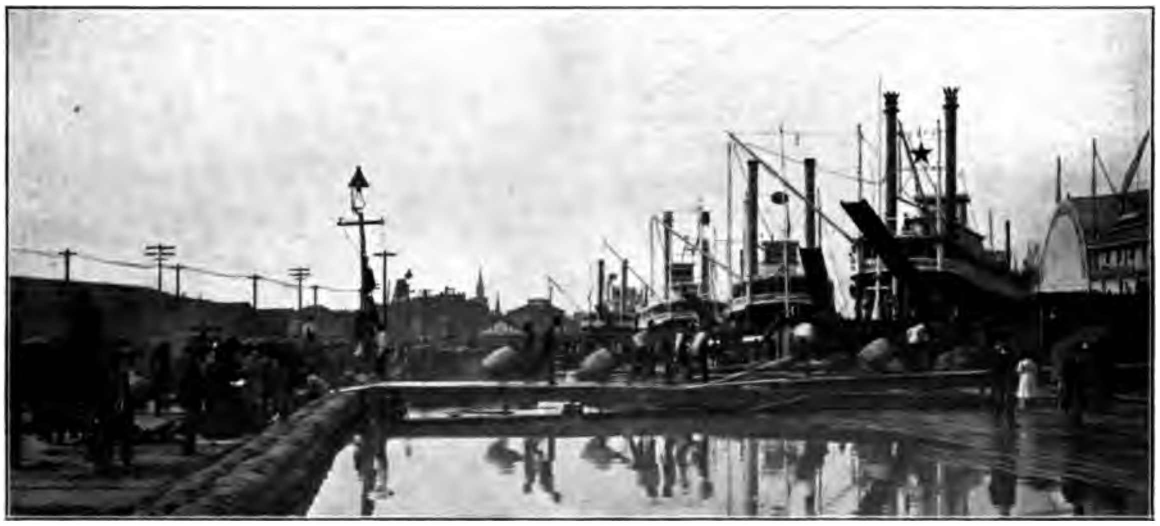
SHIPPING COAL DOWN THE MISSISSIPPI RIVER — FLEET PASSING OUT UNDER OHIO RIVER BRIDGE



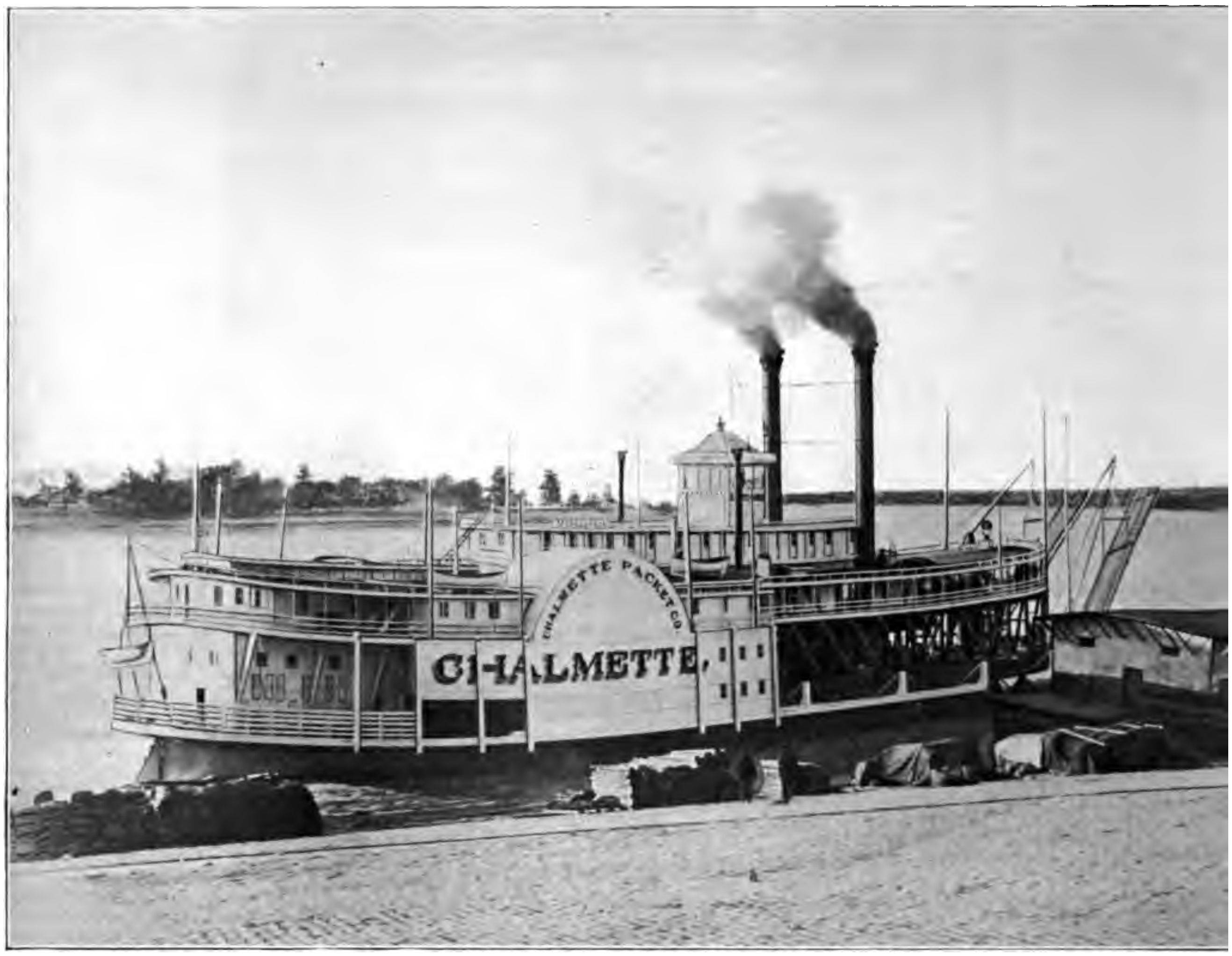
"ON THE BOSOM OF THE GREAT MISSISSIPPI"



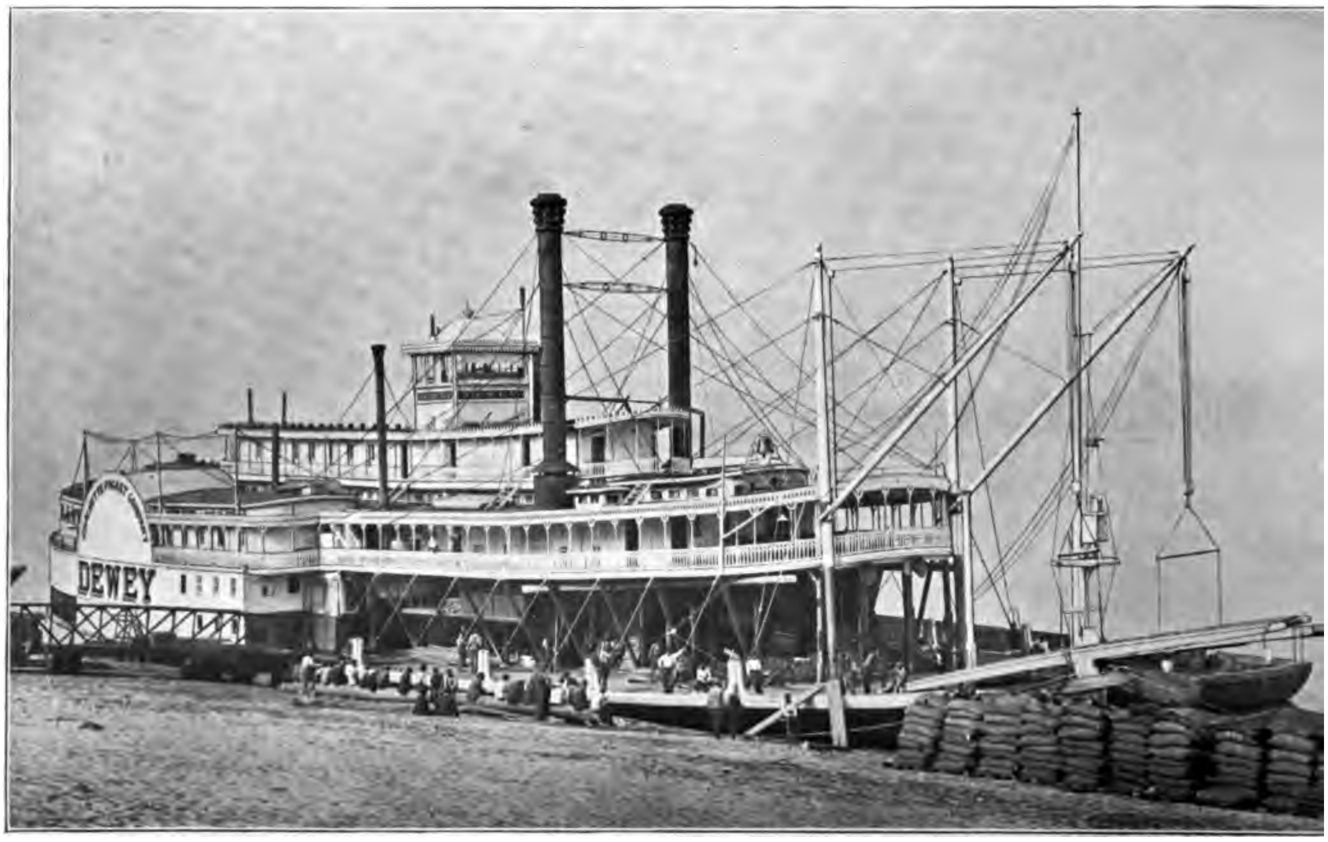
BARGE CARRYING 1,013,000 FEET OF LUMBER, SHIPPED FROM THE HARDWOOD LUMBER DISTRICTS OF SOUTHEAST MISSOURI, CARUTHERSVILLE, MO.



SCENE AT THE STEAMBOAT LANDING AT NEW ORLEANS—HIGH WATER 1897

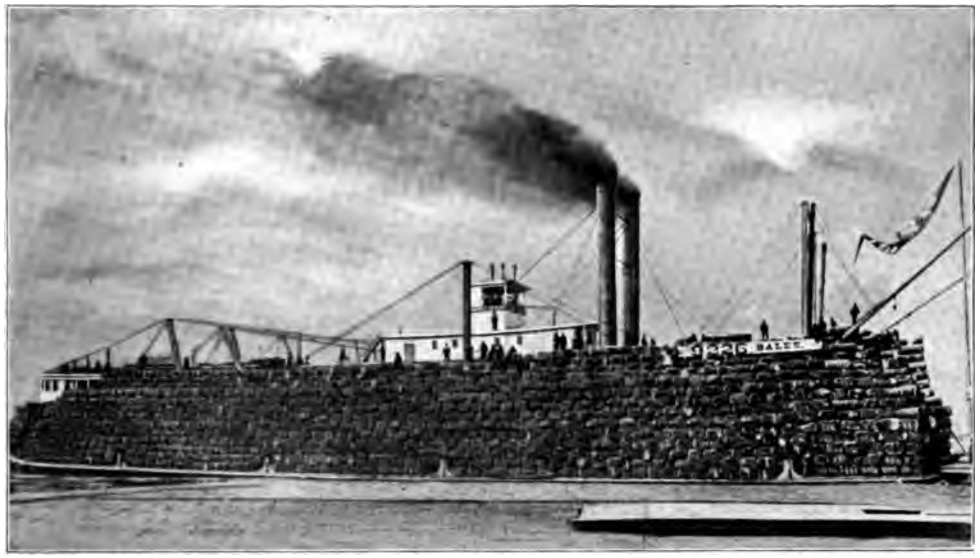


STEAMER CHALMETTE



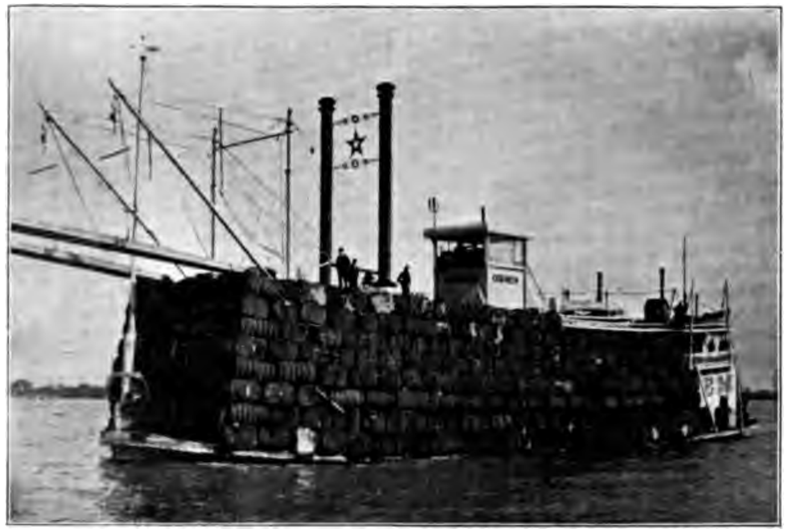
STEAMER DEWEY

STEAMER KATE ADAMS

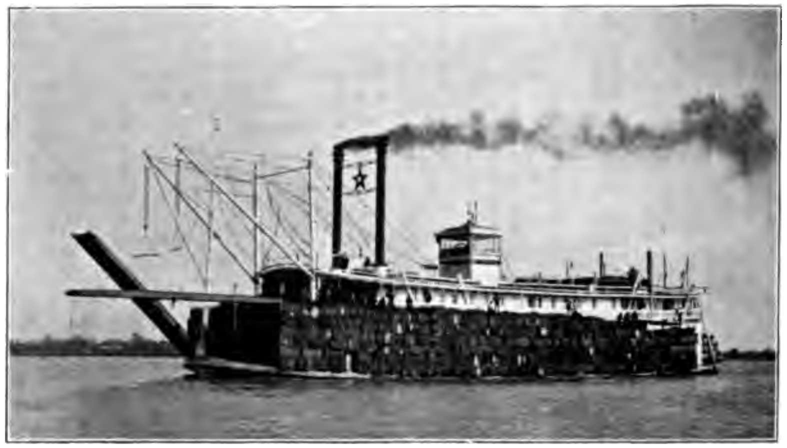


STEAMER HENRY FRANK WITH HER RECORD-BREAKING CARGO OF COTTON

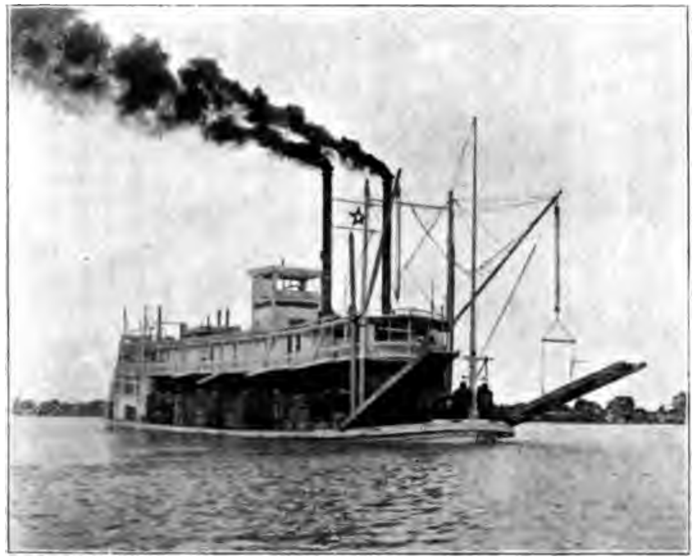
INTERIOR OF STEAMER KATE ADAMS



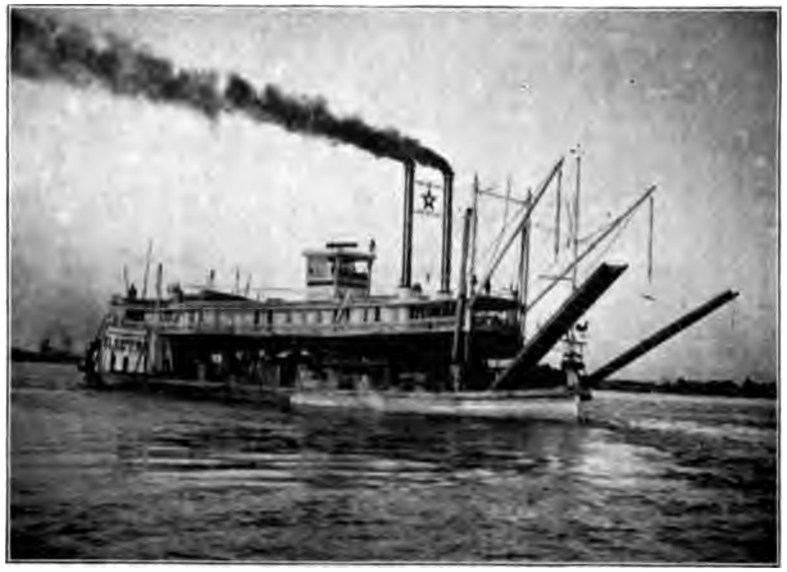
STEAMER GEM



STEAMER SUNRISE

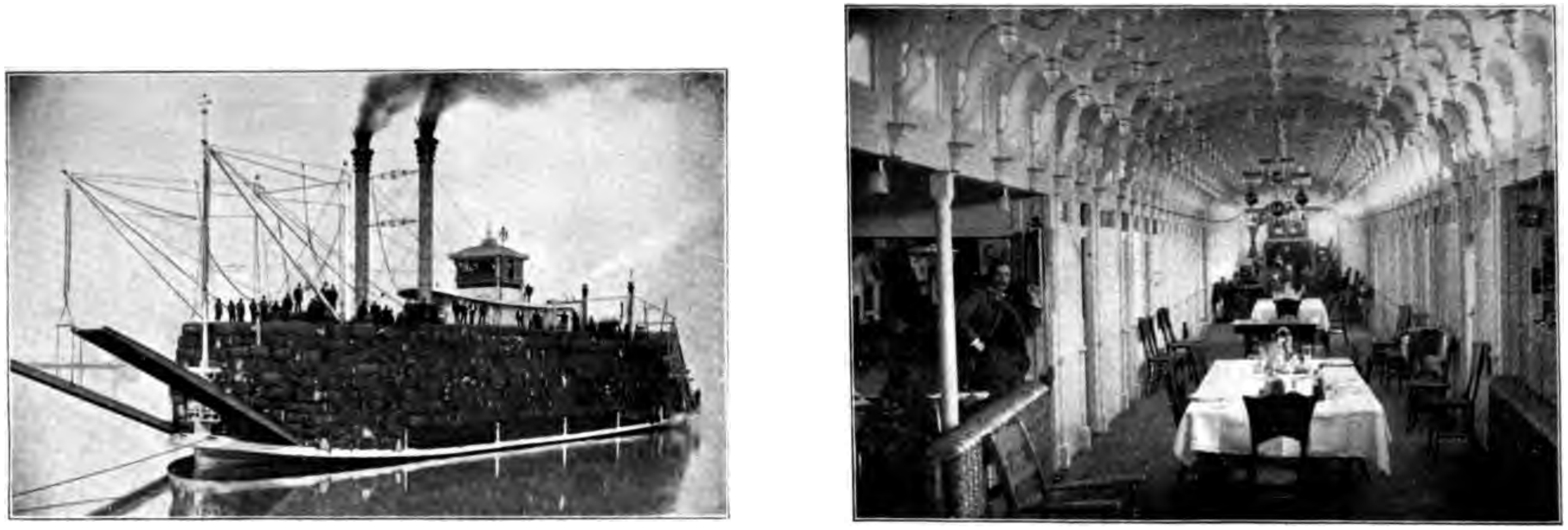


STEAMER W. T. SCOVELL



STEAMER ELECTRA

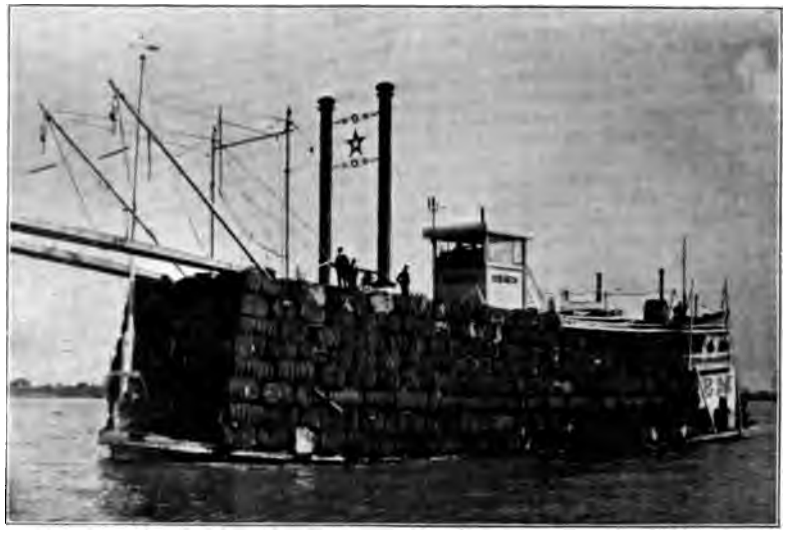
SOME STEAMERS OF THE RED RIVER LINE



STEAMER AMERICA — EXTERIOR AND INTERIOR VIEW

STEAMER WAR EAGLE

STEAMER BELLE OF THE BENDS



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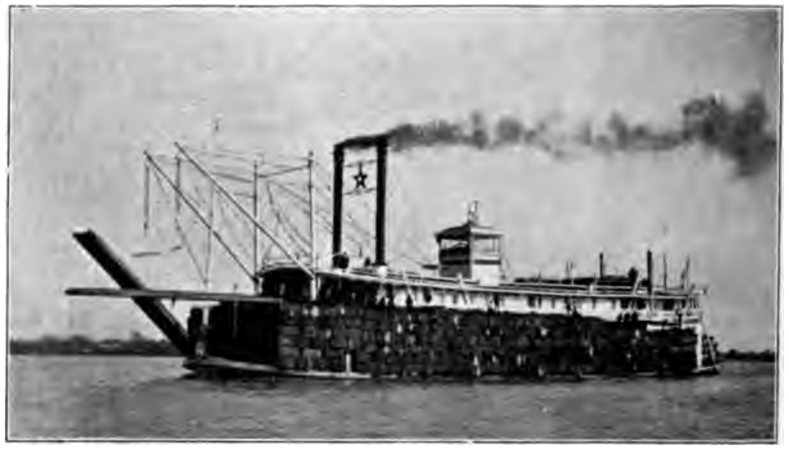
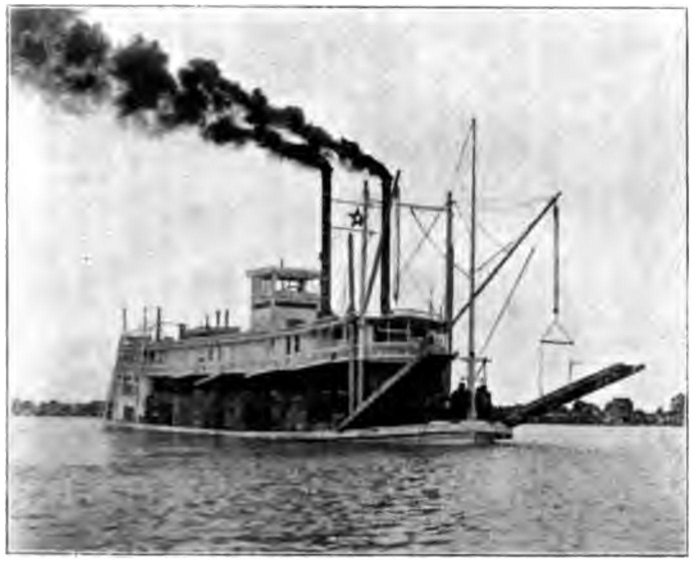


STEAMER SUNRISE



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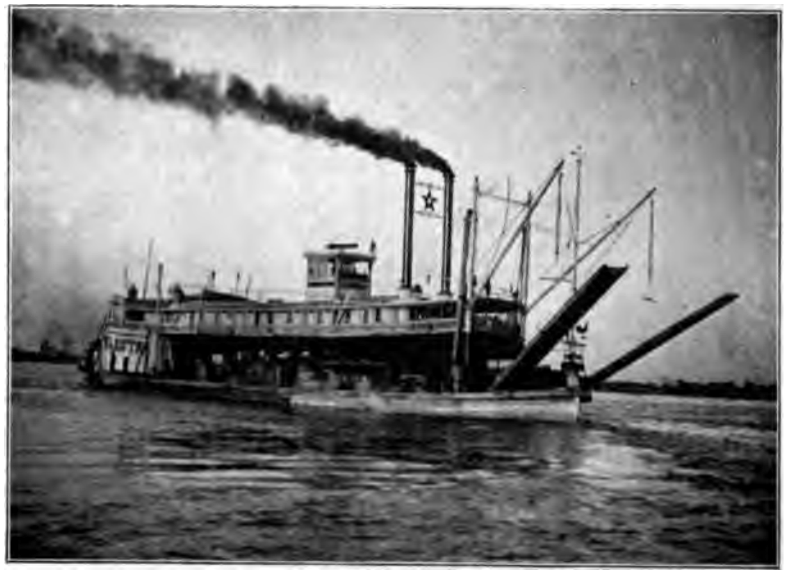

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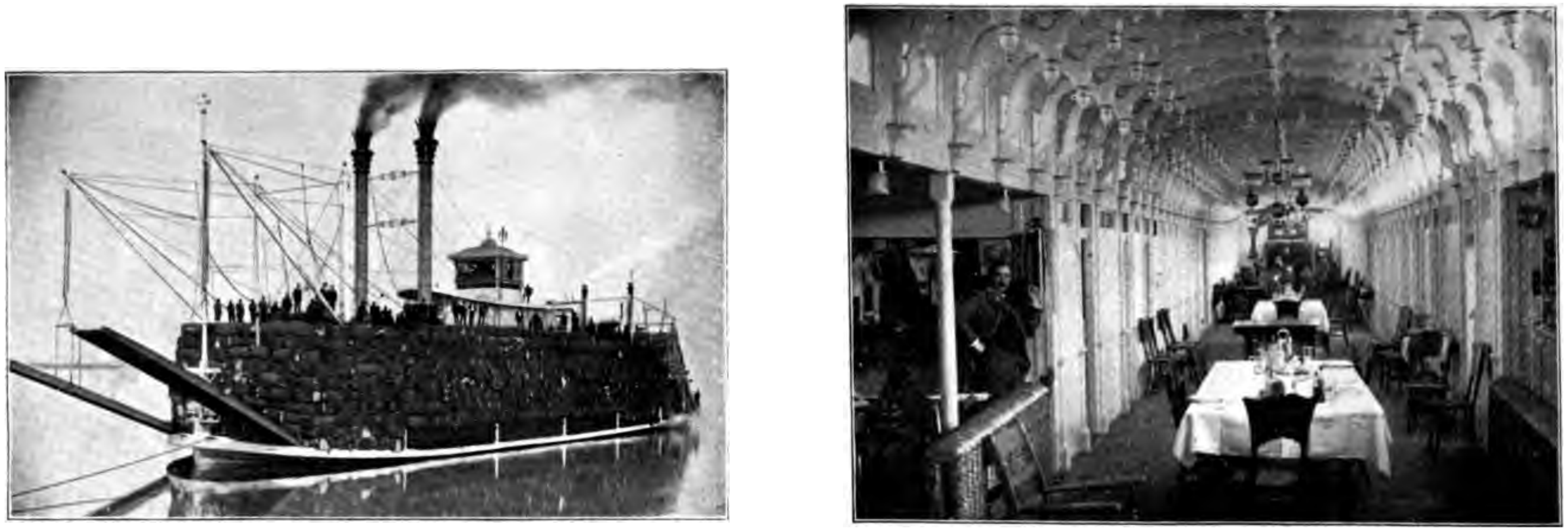
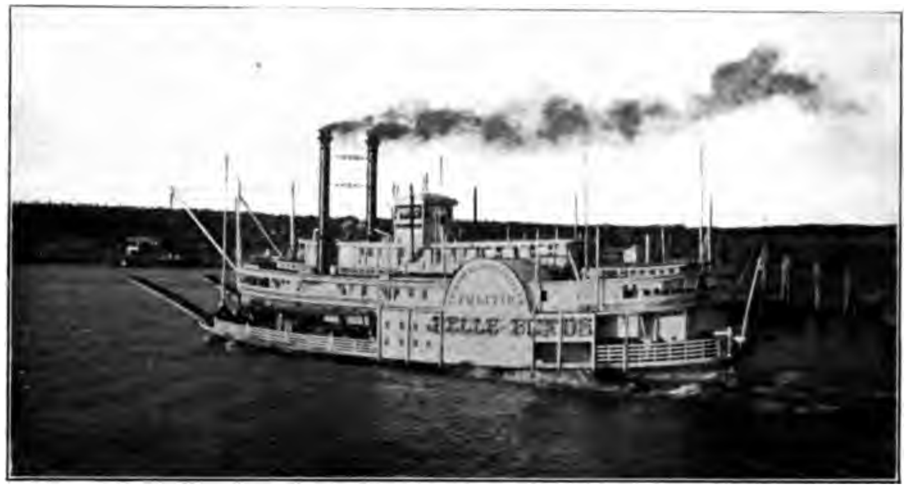
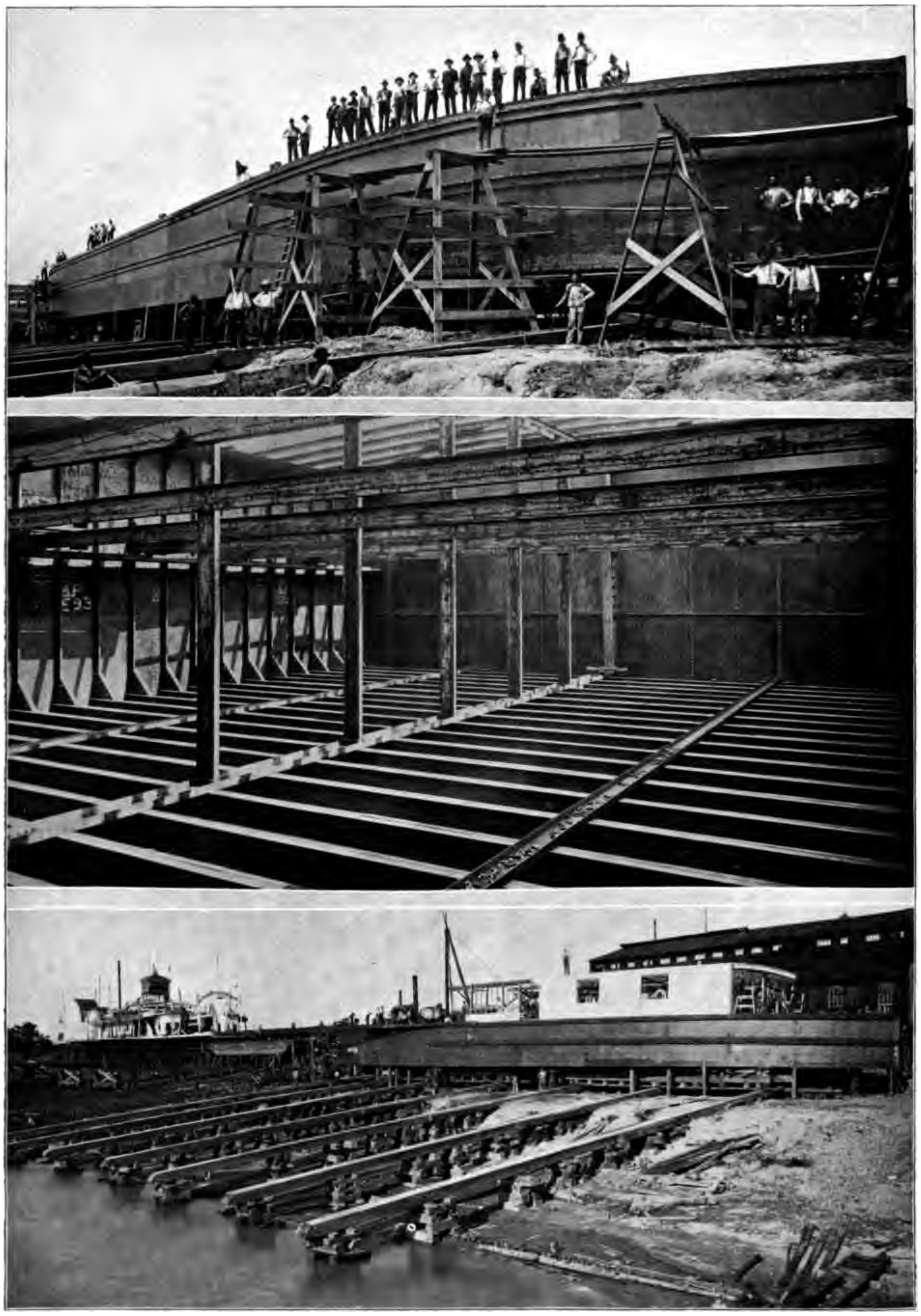


STEAMER AMERICA — EXTERIOR AND INTERIOR VIEW

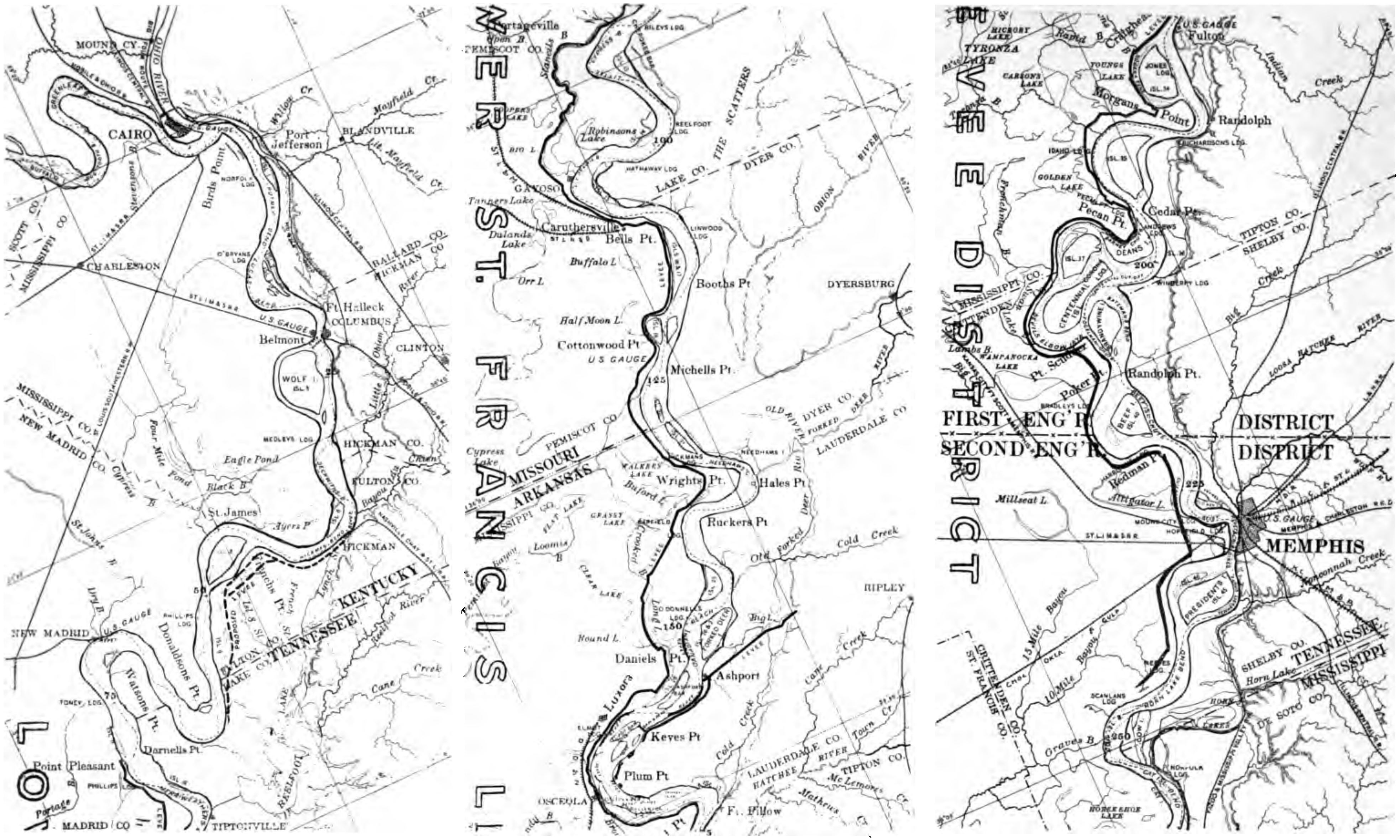
STEAMER WAR EAGLE



STEAMER BELLE OF THE BENDS



VIEWS OF NEW STEEL TOW BOAT AND BARGES IN PROCESS OF BUILDING.
(The recent successful trip from St. Louis to New Orleans and return has been noted.—Ed.)



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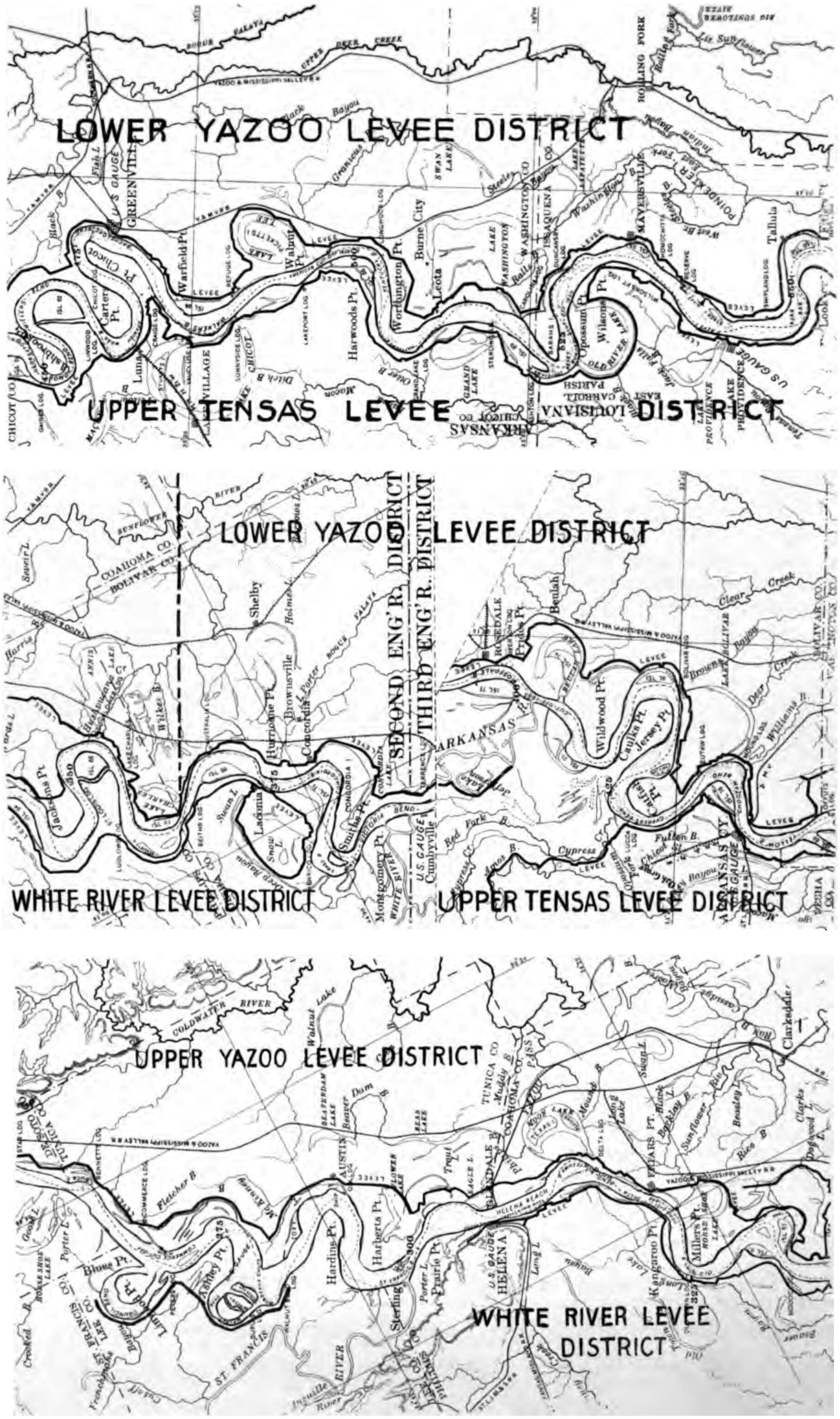
SHOWING LOCATION OF LEVEE LINES ALONG THE MISSISSIPPI RIVER.

From the Maps of the Mississippi River Commission, Corrected to Date by the Local Engineers of the Different Districts.



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SHOWING LOCATION OF LEVEE LINES ALONG THE MISSISSIPPI RIVER.
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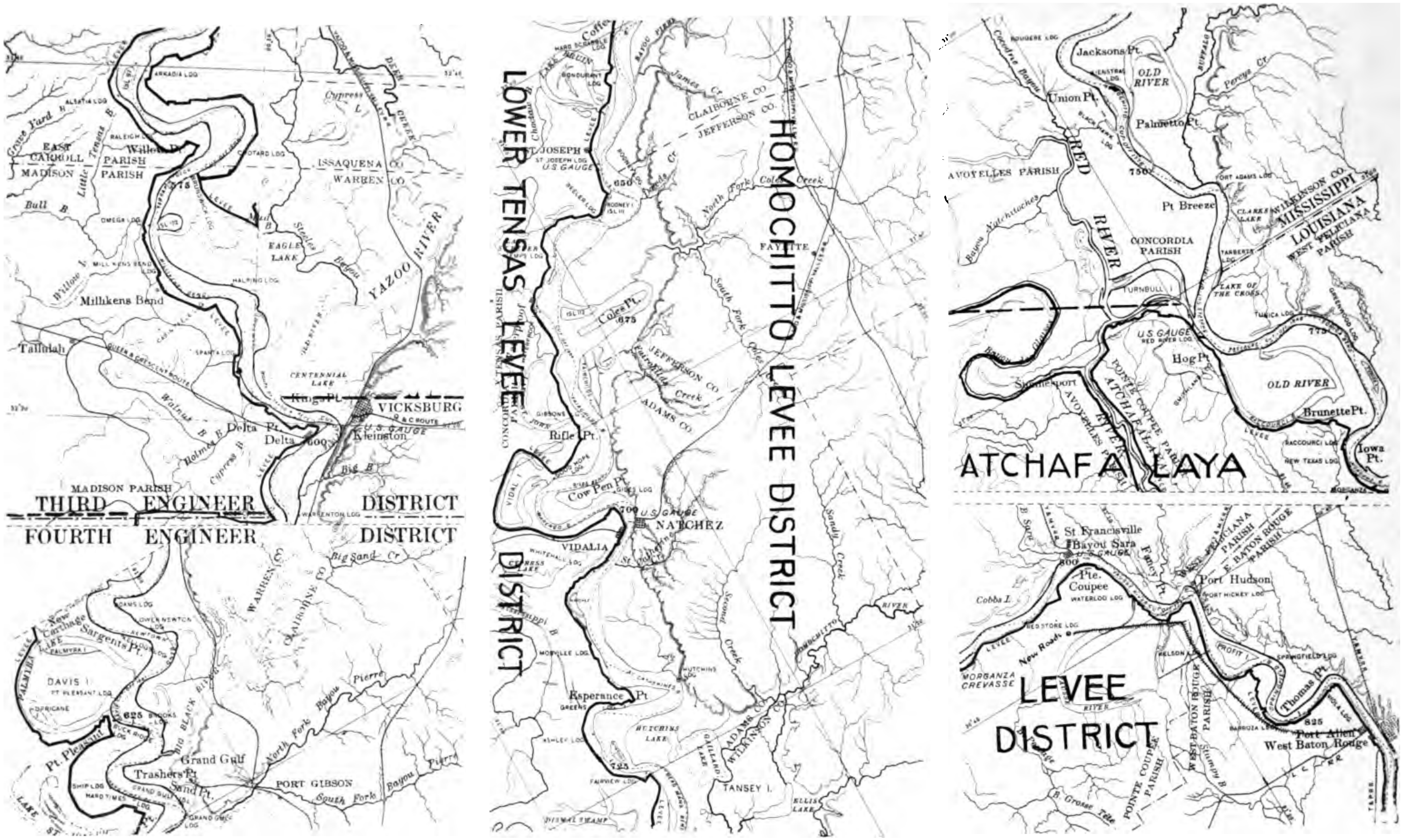

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SHOWING LOCATION OF LEVEE LINES ALONG THE MISSISSIPPI RIVER.

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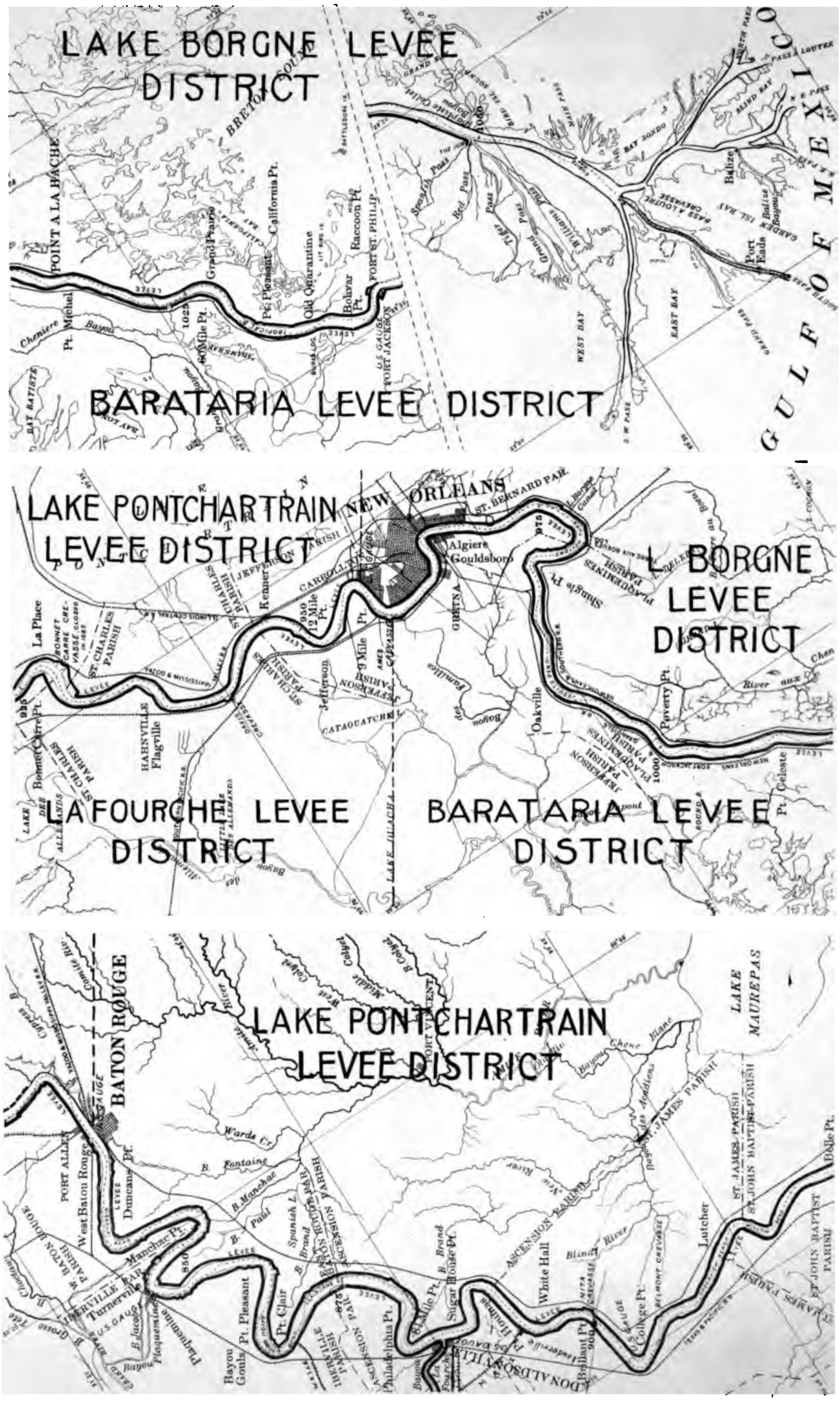


SHOWING LOCATION OF LEVEE LINES ALONG THE MISSISSIPPI RIVER.
From the Maps of the Mississippi River Commission Corrected to Date by the Local Engineers of the Different Districts.

A BRIEF HISTORY OF THE OPERATIONS OF THE YAZOO-MISSISSIPPI DELTA LEVEE BOARD—ORGANIZATION

FROM REPORT OF CHIEF ENGINEER, ARRANGED BY CAPT. A. L. DABNEY, ASS'T CHIEF ENGINEER

In the beginning of the year 1884 the Yazoo-Mississippi Delta Levee District was organized by an act of the Legislature, with power to issue $500,000 in bonds. At that time the district was in a most deplorable condition, having been swept over its entire length and breath by three successive overflows. As a consequence great industrial depression prevailed. Many plantations had been abandoned and the planters were greatly discouraged. As a rule, every man was willing to sell out, but none desired to purchase. There had been no levee organization existing for six or eight years, and the administration of levee matters by the last preceding Levee Board, in the early seventies, had been characterized by all the extravagance, waste and inefficiency incident to public organizations during the "reconstruction era." This naturally resulted in a feeling of apathy on the part of the people towards levees, which was accentuated, after the collapse of that Levee Board, by a succession of low water years, when levees were little needed. But the disastrous overflows of 1882, '83 and '84 aroused them to the necessity of action if the country was still to be man's habitation, with the present organization as the result: Former experience had made people jealous and apprehensive on the subject, and in framing the levee law great pains were taken to prevent the possibility of peculation and maladministration of levee affairs. The restrictions in the law were at first so severe as to impair the Board's power for necessary action, and were subsequently somewhat modified.

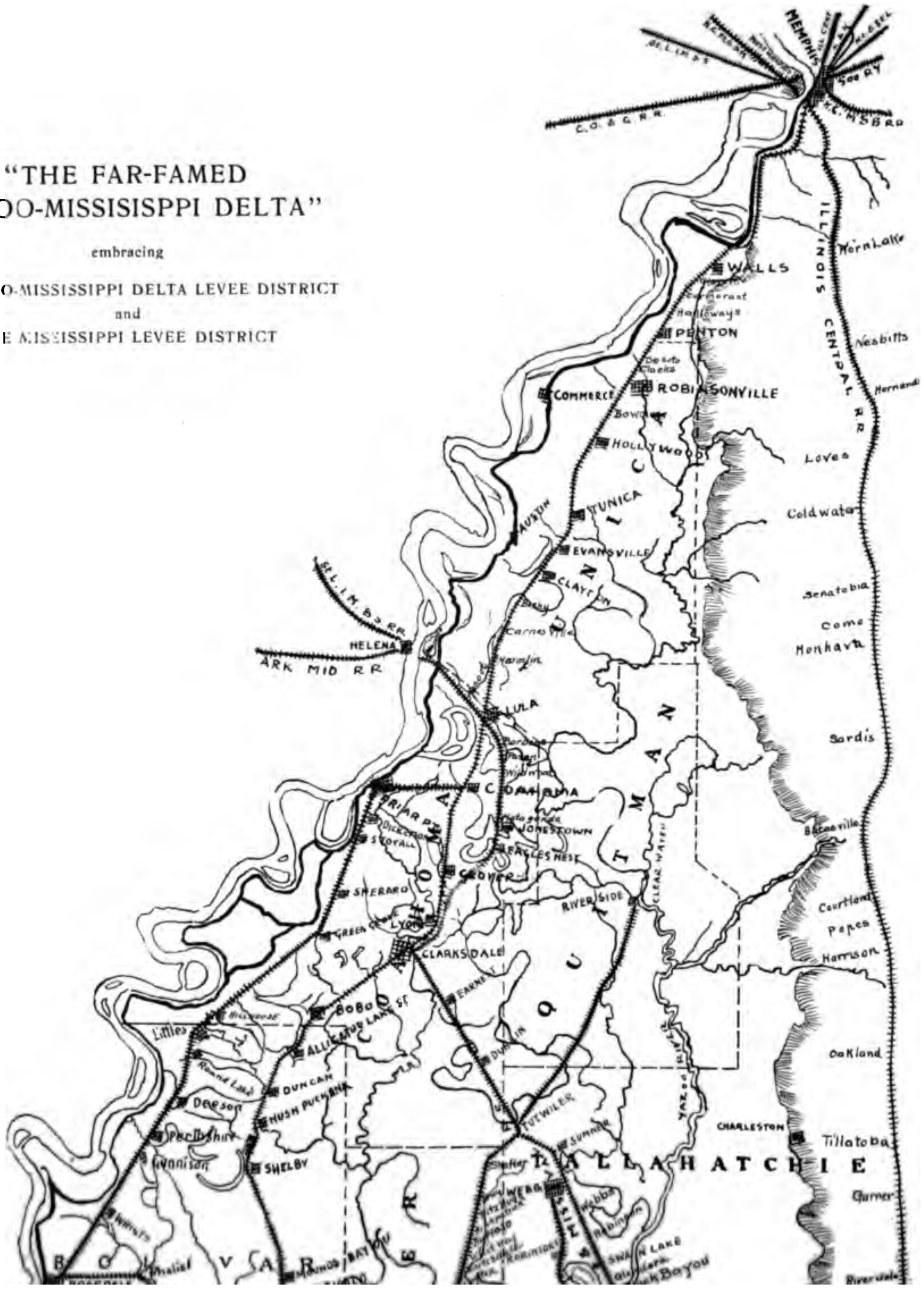
NEGOTIATING THE BONDS

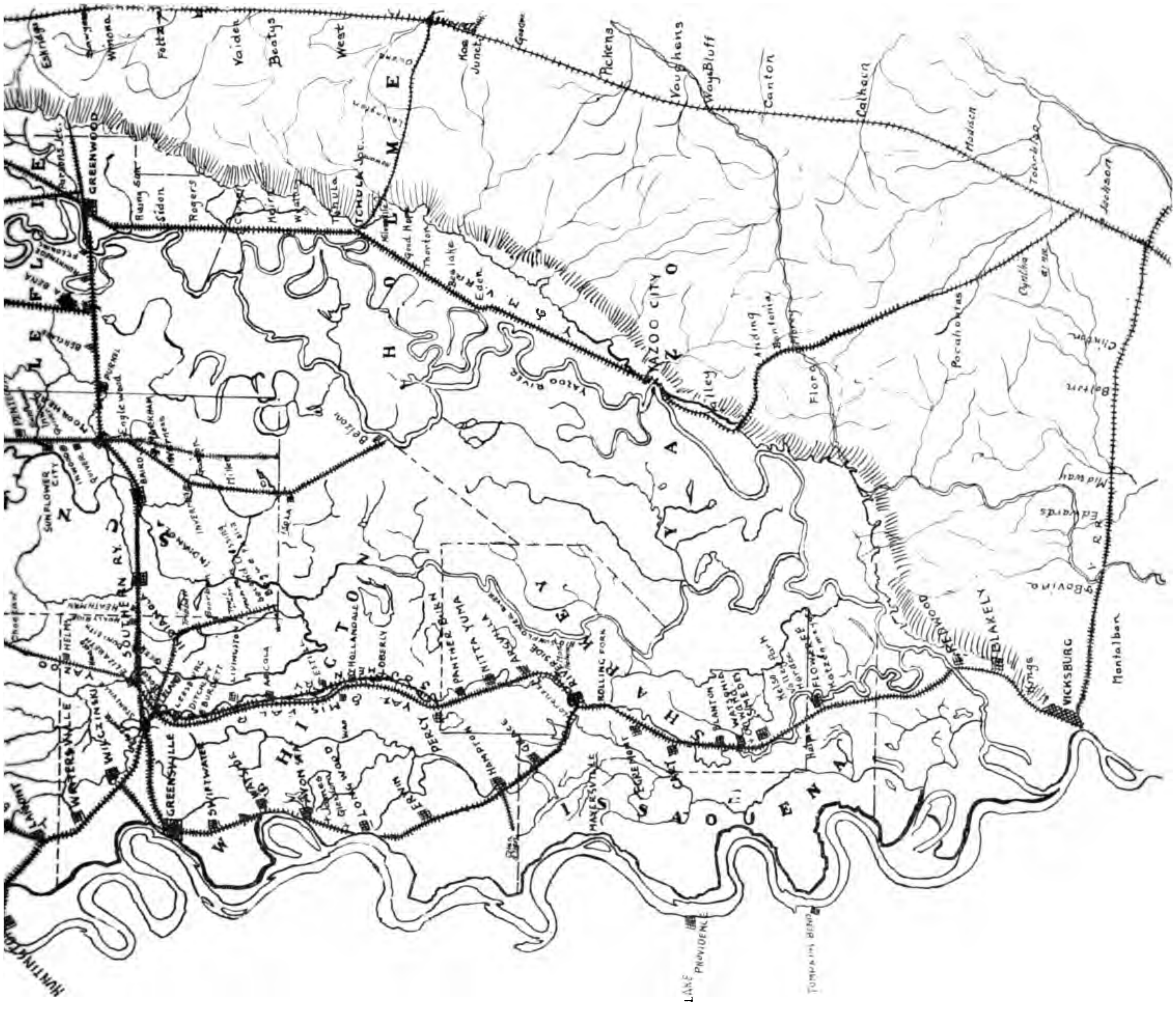
When this Levee Board was organized and began operations in the spring of 1884, the only money at their command was a few thousand dollars, raised by private subscription, for the purpose of making a preliminary survey and estimate. This had to be done hastily and imperfectly, to be laid before the Mississippi River Commission in July. The result showed that the amount of bonds authorized by the Legislature, if successfully floated, would yield less than half enough money to put up the levees north of the Hushpuckana to the standard then aimed at. The Mississippi River Commission had then no means with which to aid the Levee Board, and persistent efforts to raise money on the bonds, during the summer and early fall, failed of results. Early in October the Board had a final adjournment and gave up the case as a "lost cause." R. T. Wilson & Co. were deeply interested in the enterprise and were disposed to give their aid, but had grave doubts whether that amount of money would accomplish enough good to justify the venture on their part. They came forward, however, after the final adjournment of the Board, and offered to find money to cash the bonds at par, charging 2½ per cent. commission for the service, making it also a condition that the Mississippi Valley Construction Company should have the contract for doing all the work at 25 cents per cubic yard. The Board was called together once more to consider this proposition, which revived a hope that had been dead; and, after due deliberation, the terms proposed were accepted. At that time the price demanded for undertaking to do all this work was not excessive, as it embraced all the incidentals of clearing and grubbing, surface breaking, sodding, etc., besides assuming all risks from floods, and the obligation to have all the work completed before the next high water, the time then being apparently short. The work was parcelled out to several levee contractors, and in the outcome the construction company realized 7 per cent. profit on their outlay, as the record shows.

"THE FAR-FAMED YAZOO-MISSISISPPI DELTA"

embracing

THE YAZOO-MISSISSIPPI DELTA LEVEE DISTRICT
and
THE MISSISSIPPI LEVEE DISTRICT

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Clinton
Pocahontas
Flora
Montalban
Huntington
Wilczinski
Sunflower City
Leland
Arcola
Hollandale
Panther Burn
Nitta Yuma
Anguilla
Percy
Hampton
Swiftwater
Southern Ry.
Yazoo River
Vaughans
Way Bluff
Y. & M. V.
WASHINGTON
SHARKEY
ISSAQUENA
HOLMES
YAZOO
LEFLORE
SUNFLOWER

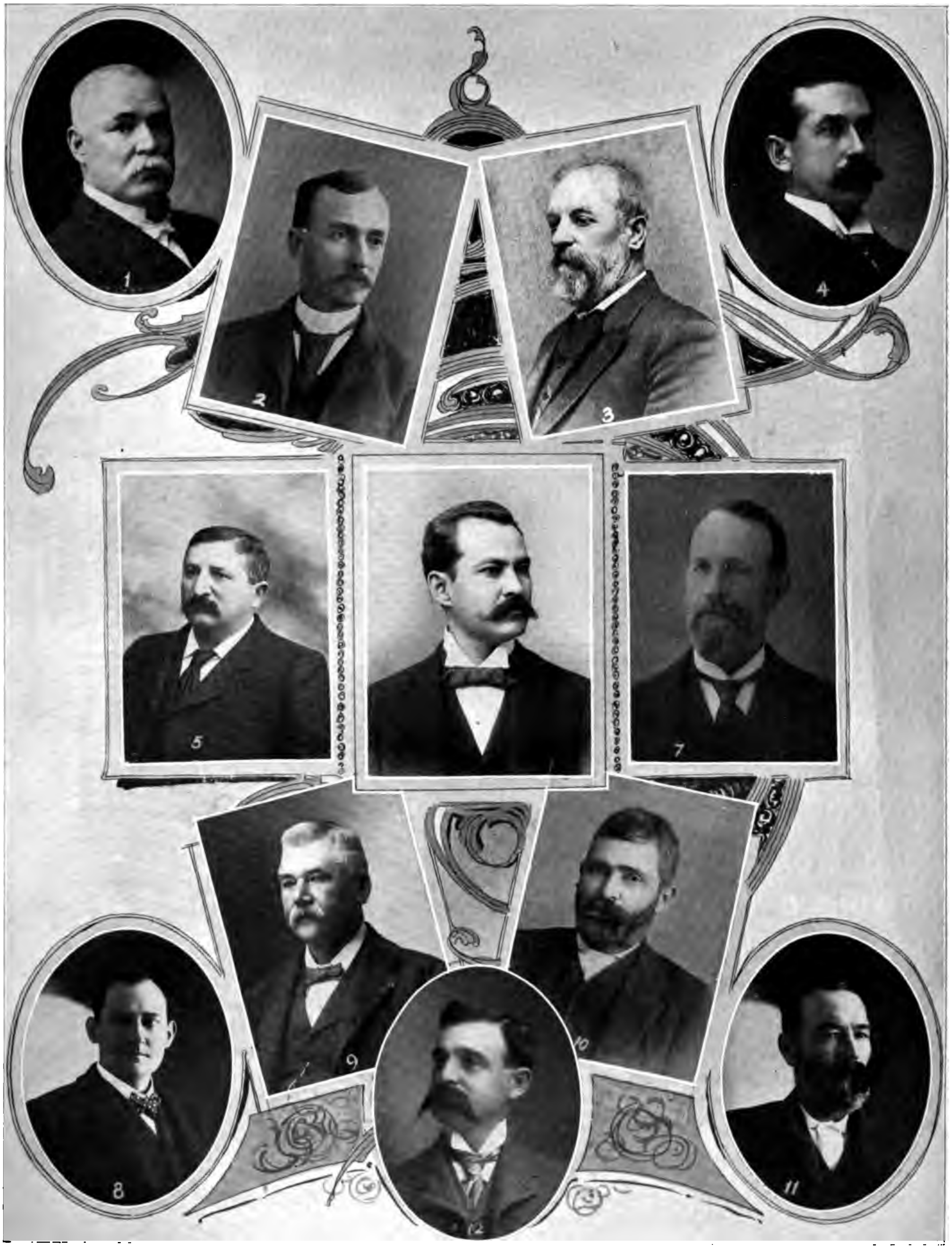
WM. H. STOVALL

D. M. RUSSELL

D. A. SCOTT

THE LATE B. S. RICKS

A. L. DABNEY
Assistant Chief Engineer



J. W. CUTRER, President (center), Coahoma County. 1. ALBERT A. SHARP, Y. & M. V. R. R. 2. W. J. KYLE, Tunica County.
3. IRA G. HOLLOWAY, De Soto County. 4. E. L. ANDERSON, Coahoma County. 5. L. MARKS, Quitman County.
7. WALTER L. KEIRN, V. Pres. Holmes County. 8. T. G. JAMES, Tallahatchie County. 9. R. V. POWERS, Yazoo County.
10. R. C. IRWIN, Tunica County. 11. B. L. JONES, La Flore County. 12. J. A. CRAWFORD, Sunflower County.

BOARD OF COMMISSIONERS, YAZOO-MISSISSIPPI LEVEE DISTRICT

EXTENT OF JURISDICTION

At the beginning of its career this Board assumed control of that part of the river front lying north of the Hushpuckana bayou only, leaving the twelve miles of levee between that point and the Bolivar County line to the care of the Greenville Board. Subsequently the jurisdiction of this Board was extended over the entire front of Coahoma County.

CONDITION OF THE LEVEES IN 1884

The first survey of the levees, in 1884, disclosed a condition that was rather appalling to an engineer who assumed the task of protecting the district from overflow, with an uncertain prospect of a very insufficient fund with which to accomplish it. There then existed an aggregate of thirty-nine miles of actual gaps in the levees north of the Hushpuckana, and about an equal extent of levee over which the water had flowed freely during the preceeding floods. The remaining fragments were, as a rule, so insignificant in height and other dimensions as would make them now an object of ridicule to levee engineers. Added to this was the further fact that the methods of original construction were crude and imperfect, and many cases of fraudulent practices were disclosed in the presence of cribs of wood and other forbidden matters found embodied in the old levees. They had, moreover, been for a long time utterly neglected, and in many cases were so overgrown with trees, cane and thickets as to be scarcely distinguishable from the surrounding forests. When it is remembered that cottonwood and sweet gum trees will in a few years attain a considerable size, producing roots enough to honeycomb a levee, and many of them will in a few years die and disappear, leaving no evidence above ground that they had once existed, this, coupled with other features of weakness mentioned above, leaves small room for wonder that the old system of levees was rotten and full of leaks from one end to the other, and levee protection had largely come to be regarded as a failure. Neither is it surprising that this frail line of defenses should have yielded like chaff to the floods that had recently attacked it, and broken into hundreds of fragments under the pressure. A large part of the work of renovating this levee system consisted in digging and carving out these numerous imperfections in the old levee wherever they were detected. Of the five crevasses that have occurred in this district since 1884, all but one were caused by concealed defects in the old levee.

LEVEE CONSTRUCTION IN 1884

When arrangements were consummated on October 10th, 1884, for applying the $500,000 to the work of reconstructing the levees, the Engineer Department labored under extraordinary difficulties, for lack of preparation for this large task suddenly thrust upon it. Being without a single instrument, without an assistant engineer, without an office even, with meager information upon which to base estimates, grade lines, etc., all of these things had to be provided with great promptitude, and a corps of seven assistant engineers organized and distributed along the ninety odd miles of levee line, with proper instruments and instructions, to provide for all the contractors and sub-contractors who were hastening to occupy the field with their working forces. The work was pushed with vigor, and by March, 1885, was all completed in a satisfactory manner. By these operations all the existing gaps in the levees were closed, the low levees raised to a higher grade, and the weak places strengthened.

Although the available fund had to be distributed over an extended front and fell short of the requirements of the situation, a reasonably strong line of defense, with reference to the high water of that period, was secured for the entire distance, which so inspired the people with confidence and hope that the Legislature of 1886 did not hesitate to authorize a further issue of $400,000 of 6 per cent. bonds for construction purposes. The annual revenues from taxation also increased in a marked degree, affording a surplus of about $100,000 a year for application to the work of construction.

INDUSTRIAL PROSPERITY

The industrial conditions of the district underwent a great revolution: property values went up, and from a state of extreme depression the country leaped into one of industrial activity. This was evidenced in the greatly increasing revenues from levee taxation.

In one county the levee tax yielded 300 per cent. more in 1890 than in 1884 (with an increase in the tax rate from 9 to 12½ mills ad valorem).

RESULT OF LEVEE PROTECTION

The general result of the efforts of the present levee administration to protect this district from overflow has been that a majority of the people in the district have seen no Mississippi river water since 1884, except in the streams and channels. It is also demonstrated that one or two breaks in the levees, under most circumstances, would produce only local disaster of limited extent, as the channels of the basin are capacious enough to convey away such a volume of water as would escape from the river, with but slight injury, except in the vicinity of the breaks.

THE SYSTEM OF LEVEE LINES

The levee system of this district is somewhat complicated by the discharge of the Hushpuckana drainage basin into the Mississippi river at Sunflower Landing. It was impracticable, within reasonable limits of cost, to cross the two miles of very low swamp lying along the river bank here. To prevent the escape of water into the district through this gap, the levee from below Hushpuckana was extended northward along a high ridge behind the swamp, to a distance of fourteen miles above the lower end of the gap. It extends to above the head of backwater, being located from two to five miles behind the front levee. Afterwards the "Ward Lake Levee," five miles long, was built, connecting the front and back levees. This line was built for the local protection of the land between the levees. The total length of the levees in this district, after the abandonment of three miles at the lower end of the front line, is 120 miles. It developed, after the occurrence of the Rescue crevasse of 1897, that to abandon this three miles (lying immediately below it) would not materially raise the backwater plane.

The levees are divided into one mile sections, marked off by numbered stones.

GRADES

The system of grades, as first adopted, was three feet above the flood plane of 1882. Where higher stages occurred in subsequent years, the grades were revised from time to time to suit the newly developed conditions. Since the 1897 flood enlargements have been made to grades varying from one to three and one-half feet above its plane, according to the importance of the levee and the amount of money available. It is designed to increase these enlargements in future, bringing the levee to a standard grade to be adopted with reference to the ultimate high water plane developed after all of the open basins on the river shall have been closed.

EFFECT OF CLOSING WHITE RIVER BASIN

During a few years past the work of closing the White River Basin had been pushed by the United States engineers, and the 1897 flood found a continuous barrier from Helena to Henrico—a distance of 78 miles. In 1893 there was still a gap of 25 miles opposite lower Coahoma County. The effect of this degree of contraction of the gap was to increase the flood height one foot on section 81, eleven miles below Friars Point, while the Cairo stage that year was 2.5 feet below its maximum. For some miles above and below the effect was felt, but was greatest at section 81.

In 1897 there was a further increase of the flood height at section 81 to 7.1 feet above the 1882 flood. This difference would have been greater by at least two feet had there been no crevasses on White river front.

It is estimated that, on section 87, the 1897 stage would have been about 10 feet above the 1882 stage. The complete closing of the St. Francis front must inevitably increase this water height.

IMPROVED METHODS OF CONSTRUCTION

As a consequence of the combination of insufficient present resources and varying flood conditions, the levee systems have grown up as a system of patch-work, which effect is heightened by progress in better methods of levee construction, great advancement having been made in this direction during the past dozen years in consequence of greater demands on the resisting powers of levees and a more determined effort than ever before made to successfully control the floods of the Mississippi river. Much of the improvement in the methods of levee building is due also to the growing experience of engineers and a more serious purpose to study the subject closely. Indeed, prior to about the year 1884 lack of means so dominated in levee matters that very unscientific methods of construction and location were necessarily resorted to, with the inevitable result of uneconomical expenditure of money, and levees that gave way under the pressure of every high water.

With the infusion of Government funds in recent years, and increased means from local sources, much more thorough methods of construction have been introduced, and we now build levees to stand high water without breaking.

COST OF LEVEE PROTECTION

It is probably fortunate for the interests of levee protection that it could not be foreseen, a dozen years ago, what increasing demands would arise to build levees that would certainly give security from overflow, and to meet increasing flood elevations, due to increasing progress in levee extension. A complete foreknowledge of the enormous expenditures involved, instead of a gradual realization, would probably have discouraged all attempts at beginning, whereas enough has already been accomplished in this district to justify the expenditure made, and complete and permanent security from overflow is now easily within the grasp of the people, provided there is no relaxation in their efforts until it is accomplished.

COMPLETION OF THE LEVEE SYSTEM AND ULTIMATE RESULTS

The work of confining the entire volume of water to the channel of the river will probably reach its completion in a few years. With this consummation we may expect to be able to ascertain the ultimate maximum flood heights to which our levee systems must be adjusted for future security from overflow.

STATEMENT OF EXPENDITURE

The following is a statement of the expenditures of this levee district for all purposes, from the date of its organization to May 1st, 1900:

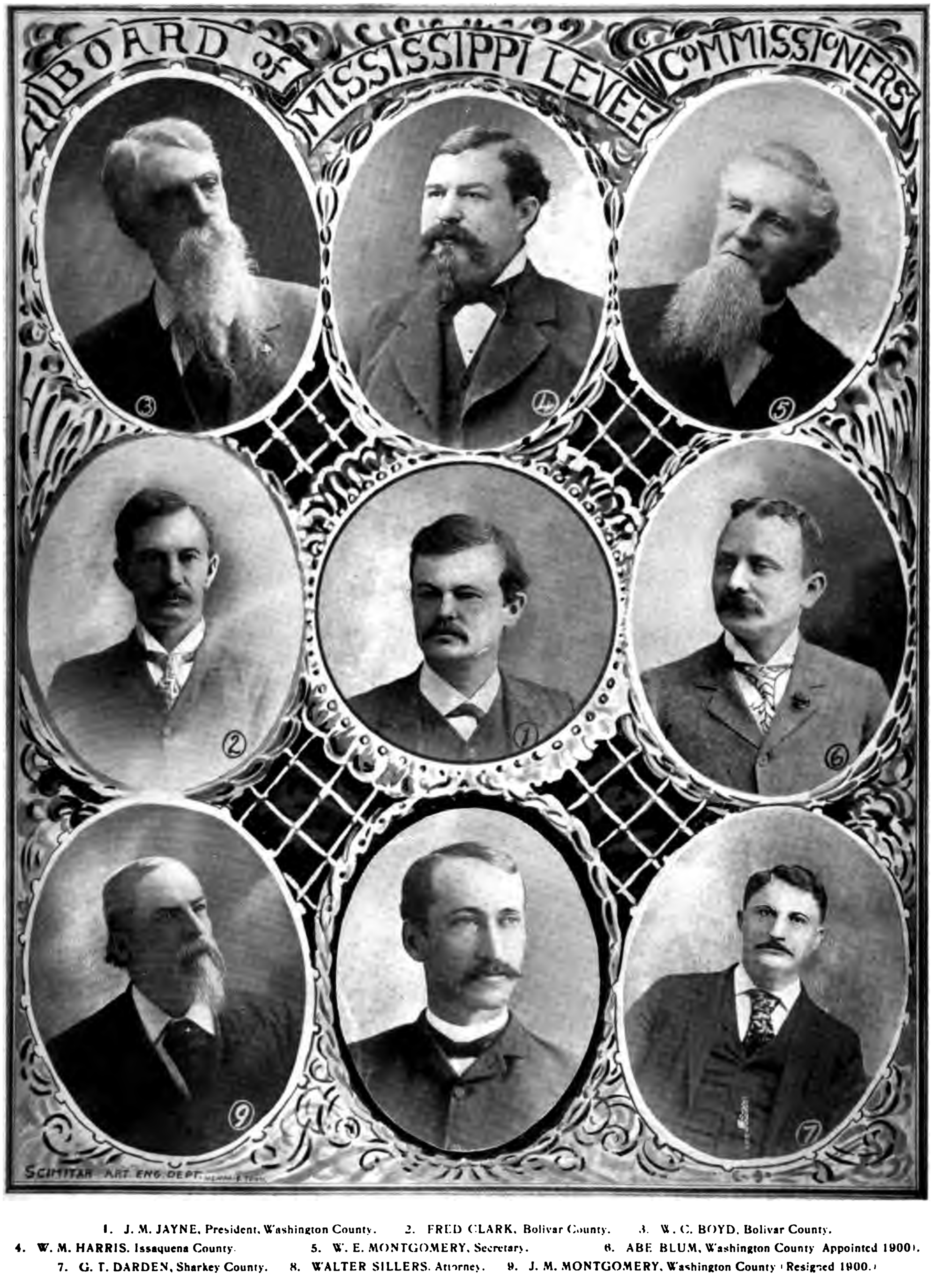
It should be noted that the item of "construction" embraces, besides the "cubic yards," all extra work, such as clearing, grubbing, sodding, etc. Also that the item of "levee maintenance" includes the cost of a repair force, which has been at work constantly, and employed mainly in adding dirt to the levee where conditions were such as to make it impracticable to secure measurements of this work in cubic yards.

To have these figures would materially increase the aggregate shown below. A considerable expenditure was made for extra work on United States Government contracts, not provided for in the Government specifications.

The item "engineering expenses" embraces much expenditure outside of the pay received by the engineers, of a character too miscellaneous to enumerate.

Construction, 13,376,933 cubic yards	$2,496,852.90
Levee maintenance (including some construction by repair force)	214,924.89
All other expenditures	1,768,338.73
Total expenditures by Levee Board	$4,480,116.52
Total appropriations to this district by U. S. Government in same time	$933,750.00

The district has issued its bonds to the amount of $1,400,000.00, the proceeds from the sale of which were applied to levee purposes. Of these bonds the sum of $323,000.00 have been purchased by the Board and canceled.


BOARD of MISSISSIPPI LEVEE COMMISSIONERS
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SCIMITAR ART ENG. DEPT.

1. J. M. JAYNE, President, Washington County. 2. FRED CLARK, Bolivar County. 3. W. C. BOYD, Bolivar County.
4. W. M. HARRIS, Issaquena County. 5. W. E. MONTGOMERY, Secretary. 6. ABE BLUM, Washington County (Appointed 1900).
7. G. T. DARDEN, Sharkey County. 8. WALTER SILLERS, Attorney. 9. J. M. MONTGOMERY, Washington County (Resigned 1900.)

C. H. WEST
Chief Engineer

W. C. DULANEY
Former Collector

GEO. M. HELM
Former Chief Engineer

ROBERT SOMERVILLE
Assistant Chief Engineer

OF THE MISSISSIPPI LEVEE DISTRICT

BRIEF HISTORY OF LEVEE BUILDING IN THE MISSISSIPPI LEVEE DISTRICT

BY C. H. WEST

The earliest levee building in this district was done by the planters living along the immediate river front; usually, each planter did the work on the front of his own place, but occasionally several united together in building some levee that was of mutual benefit.

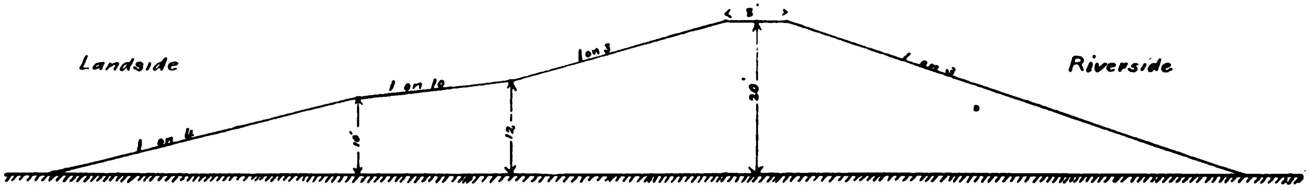
Levee building in those early days was, of course, done in a very crude manner. The first levee built in the district was in 1844, not far below the present city of Greenville. It was not until about 1855 that any organized effort was made to build levees: About that time, the County Boards of Supervisors took up the matter in their respective counties and issued warrants to pay for work done. The County Surveyor was sometimes employed to run out a line along which the embankment was to be built, but no engineer was employed to lay out or supervise the construction of the work. The first Levee Board was organized in 1858. This Board assumed the debts of the Local County Boards, organized an engineer force, and for the first time was there any system about the location and building of levees in this district. James L. Alcorn was the President, and Minor Meriwether the Chief Engineer of this Board. This Board ceased operations in 1861, and during the four years following no effort was made to keep up the levees, and at the close of the civil war, owing to crevasses and other causes, the levees had deteriorated to such an extent that the country was without protection from the floods of even moderate high waters. The amount of work done, or money expended for levees up to this time is not certainly known; it was considerable, however, and altogether probably reached nearly a million dollars.

The present Levee Board, known as the Board of Mississippi Levee Commissioners, was organized in 1865. The front of the district now extends from the Coahoma-Bolivar County line to a point in Warren County, just above the mouth of the Yazoo River. The length of the river front is about 230 miles, and the length of the present controlling levee line 190 miles. The territory subject to taxation embraces Bolivar, Washington, Issaquena, Sharkey and a small part of Warren Counties, with an area of 2,593 square miles. The present gross revenues of the Board amount to about $300,000 annually. The rate of taxation is five cents per acre on all land, five cents on every lot in cities and incorporated towns, five mills ad valorem on the assessed value of all property real and personal, and one ($1) dollar per bale on cotton. The amount expended by the Board from 1865 to July, 1882, amounted to $3,557,918.47. The great flood of 1882 ran over the levees and swept them away in many places, but instead of disheartening the people it only aroused them to the necessity of greater efforts on their own part and an appeal to the general government for assistance in giving protection from the ravages of the great river. Thus it will be seen that the lessons taught by this flood marks the beginning of a new era in levee building.

From surveys made just after the disastrous flood of 1882, it was estimated that the earthwork in the levee then existing amounted to a little over six million (6,000,000) cubic yards. Its height averaged about seven feet, but the embankment was very irregular in grade and section, and the integrity of the line broken in many places by yawning gaps caused by the recent crevasses. A discouraging outlook indeed for a people who had just suffered such a sweeping loss from the ravages of the river, and whose only hope for protection from future floods depended upon levees; but they were not disheartened, and in July, before the waters had receded from the land, delegates from all over the Delta assembled in convention at Greenville to devise ways and means for repairing and building up the levees to give better protection.

The rate of taxation already burdensome was increased, authority was asked of the State Legislature to issue bonds, and an appeal made to the general Government for assistance. Work was soon begun in earnest, and has never abated for a season since, and the levees have gradually grown in height and strength until they are now five times the volume they were in 1882. In 1884 there was one crevasse at Hughes, forty miles below the upper end of the district, and flooded only a limited portion of the territory. After this, each successive high water was held until 1890, when the levee gave way at Five Points, Catfish Point, Eastern, Huntington, Offuts and Skipwith, inundating the greater portion of the district. Again in 1891 there occurred one crevasse at Stella. After this there were no more crevasses until the great flood of 1897, when the levees were overtopped by the water and gave way in five places, viz.: Sledges, Stokes, Stops, Deerfield and Promised Land, and again nearly the entire Delta was flooded, The lessons learned from the high water of 1890 and 1891 were of great value, in teaching the necessity of greater care in preparing the foundations and in methods of constructing the levees, and from that time may be dated the true beginning of levee construction according to scientific principles.

The entire line of levee of the district now has a grade three feet above the flood plane of 1897, the highest past water; the crown width is eight feet, and the slopes "one on three" on each side, and wherever the height exceeds ten feet the section is reinforced by a banquette on the land side of the levee. This banquette usually begins about eight feet below the top of the levee and is twenty feet wide with a slope downward from the levee of "one or ten" for twenty feet, and then "one on four" to the bottom, thus:



In some localities the height of the levee is thirty feet, and over the highest ground not less than ten feet, and will average fifteen feet over the entire length of the line.

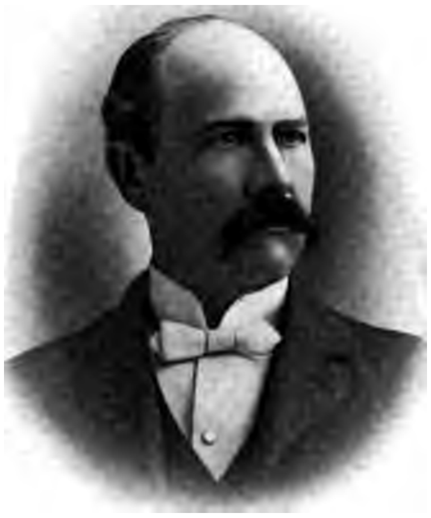
The present levee, with its uniform section and smooth, well sodded slopes, bears but little resemblance to the levees of a few years ago. From 1865 to July, 1900, this Levee Board has expended $9,326,689.47, of which $5,768,771 was expended since July, 1882. The first assistance from the United States was in 1882, and since then the total expended by the Government for levees in this district amounts to $2,861,670.84.

The greatest hindrance to the building up of a safe and permanent line of levee in this district has been the rapidly caving banks in many of the river bends. From this cause, principally, 135 miles, or over seventy per cent of the present length of the levee line of the district has been abandoned in the past eighteen years. In recent years, the policy has been adopted of locating the levees at a greater distance from the river bank than was formerly the practice, and in some places of revetting the banks to prevent the caving, where an expensive system of levee was in jeopardy.

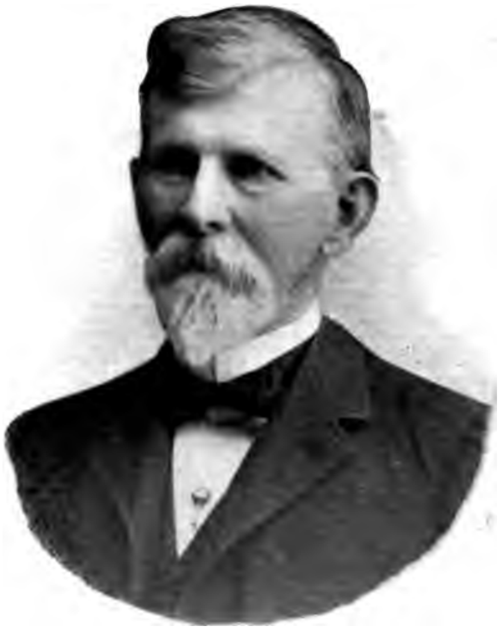
Comparing the levees of to-day with the conditions that existed a few years ago gives great encouragement to continue the work until a safe and permanent line has been completed. That this can be done is not doubted in the least by those who have been most intimately connected with the development of the system, and they confidently look to the accomplishment of this end in the near future. The system has already reached the stage that insures protection from all but the extreme floods, and it is estimated that three feet more in height, with a relative strengthening of the base, will give protection from any flood that may be expected in the future.

There yet remains much more to be done before the levees have been brought to the stage of development just indicated, but the great results that will follow are more than worth the effort, for the possibilities of this fertile valley, when once assured of protection from devastation by floods, can scarcely be estimated.

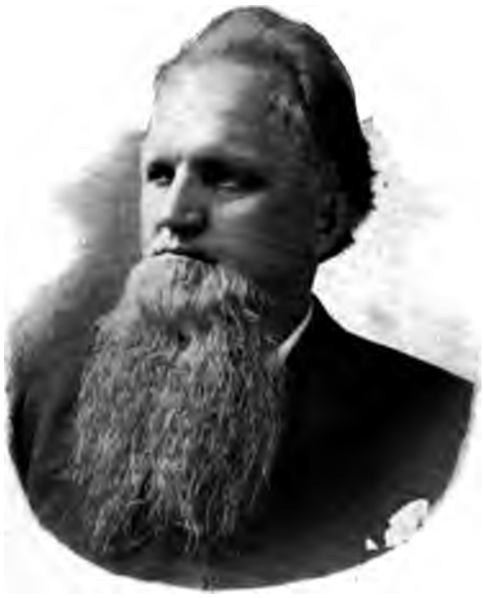
With the uncertain protection that has been and is now afforded, the improvements throughout the valley have been remarkably rapid, and with the same measure of protection, the development will doubtless continue as in the past: But with a levee system that will give certain assurance of protection from overflow, the advance and development in every line of industry that will at once take place throughout the Yazoo-Delta will be beyond that of any other territory of like area in the past history of the United States.



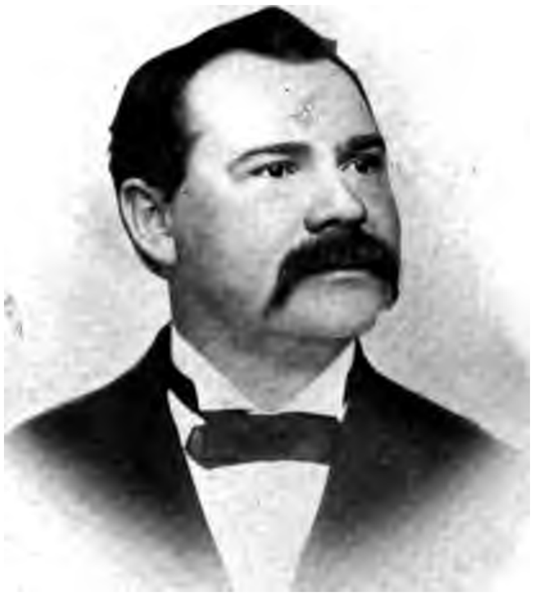
HON. A. H. LONGINO
Governor of Mississippi



R. W. MILLSAPS



THE LATE WILLIAM G. YERGER



JOHN L. HEBRON, JR.

ALPHONSE DE LISLE

J. F. GIRVIN (Deceased)

JESSE DE LISLE

W. H. HUFFMAN, President.

J. J. WILLIAMS

HINA C. SCHULT

J. A. CUNNINGHAM

ST. FRANCIS LEVEE BOARD IN MISSOURI

THE ST. FRANCIS LEVEE DISTRICT OF MISSOURI

BY HINA C. SCHULT

By a special act of the Legislature of the State of Missouri, approved March 21, 1893, "All that part or area of the State of Missouri known as a part of the St. Francis Basin, lying in the Counties of Dunklin, New Madrid and Pemiscot, subject to inundation from the Mississippi river, including all that area of territory which has heretofore at any time, either directly or indirectly, been overflowed by the waters from the Mississippi river" was formed into a Levee District. The act provided for the appointment of three persons, land holders of each County, as a Board of Directors, and named William Petty, Reuben Chapman, and John Black, of the County of Dunklin, John J. Williams, J. F. Girvin, and Alphonso DeLisle, of the County of New Madrid, and John A. Cunningham, Joseph Brasher and George W. Carleton, of the County of Pemiscot as the first Board of Directors. These Directors were appointed for a term of one, two and three years, respectively, in the order in which they are named, and their successors to be appointed by the Governor of the State on the first Monday in March in each year succeeding the year 1893. George W. Carleton died on the 31st day of March, 1893, and Hina C. Schult was appointed to fill the vacancy.

The act further provided "That said Board of Levee Directors shall have power and it is hereby made their duty, to Levee the St. Francis front in the Counties herein named in this State, and to protect and maintain the same in such effective condition as honest, able and energetic effort on their part may attain, by building, repairing and raising Levees on the right bank of the Mississippi river, or such other places as the said board may select; shall have power to employ all agents necessary to the execution of their duty; shall determine the base, crown, height, slopes and grades of the Levee, and make all needful regulations and do all acts in their opinion necessary to secure the Levee District under their charge from overflow by the waters of the Mississippi river; to assess and levy annually a tax, not exceeding five per cent of the increased value or betterment estimated to accrue from protection given against floods from the Mississippi river by said Levee, on all lands within said Levee District; shall call a meeting of the land owners in each of the respective Counties within said Levee District in each County, etc., at which time the proposition to levy said annual assessments shall be submitted to said land owners, and if a two-thirds majority of the land owners in such Levee District who appear at such meeting shall vote for such assessment, it shall then be the duty of said Board of Directors to levy annually said tax," etc.

The total number of acres of land in the District, subject to overflow from the Mississippi river is as follows: Dunklin County, 42,848 acres; New Madrid County, 135,747 acres; Pemiscot County, 269,380 acres. The lands subject to overflow in New Madrid County are in the South part of the County, and the lands in Dunklin County also are in the South part of that County (Dunklin County lying west of Pemiscot County), and nearly all the land in Pemiscot County was subject to inundation by the floods of the Mississippi river. The distance or length of the Levee commencing at the high land, at or near Pt. Pleasant, Missouri, to the State line dividing the States of Arkansas and Missouri is about forty-seven miles, about seven miles of said Levee being in New Madrid County and about forty miles in Pemiscot County.

The Board of Directors met at New Madrid, Missouri, on March 29, 1893, for the purpose of organization. The following officers were elected: Dr. J. J. Williams, President; W. D. Schult, Secretary; John A. Cunningham, Treasurer; and Capt. H. N. Pharr, Chief Engineer. The Assessors and Collectors for the various Counties were also appointed, and Pt. Pleasant, Missouri, was selected as the domicile of the Board as provided by law.

At the time of the enactment of the special law creating the St. Francis Levee District of Missouri, a similar law was passed by the State of Arkansas, creating the St. Francis Levee District of Arkansas, which comprised all that territory in the St. Francis Basin in Arkansas commencing at the State line, dividing the States of Missouri and Arkansas, and running South to the mouth of the St. Francis river. Both the Missouri and Arkansas law provided for the consolidation of the two Districts if possible.

In the year 1892, the Mississippi River Commission set apart the sum of $264,000 for the Lower St. Francis Levee District — said District commencing at the high lands at Pt. Pleasant, Missouri, and thence south to the mouth of the St. Francis river in Arkansas, a distance of 210 miles —and to be expended as follows: $88,000 in the year 1893; $88,000 in the year 1894; and $88,000 in the year 1895. The Commission set apart this money as an inducement to the people of Arkansas and Missouri to organize this territory into levee districts and to assist them in commencing the building of levees. This action of the Commission was directly the cause of the organization of these two levee districts in Missouri.

In May, 1893, the two Levee Boards of Missouri and Arkansas met at West Memphis, Ark., for the purpose of discussing the consolidation of the two districts, to determine where the first allotment of $88,000 should be spent; the Government Engineer in charge of the lower St. Francis Levee District having expressed a willingness to expend this money either in Missouri or Arkansas as requested by the two Boards in joint meeting. It was decided at this meeting that the most important work was the closing of the gap between Bear Bayou, in Arkansas, and Pt. Pleasant in Missouri. The work was advertised and Capt. Roessler on the day the contracts were to be let arrived at Pt. Pleasant.

Prior to letting the contract, he discovered that the right-of-way through some of the lands through which the levee would run could not be obtained. Some land owners refused to give the right-of-way, claiming that the Government ought to pay them for the same. The contract was let, however, conditional that the right-of-way be secured free of cost to the Government by the Board of Directors of the Missouri District. The Board used every effort to induce these people to give the right-of-way, but they absolutely refused. Right here it is but just to say that this refusal cost the people living in the St. Francis District of Missouri nearly $150,000, for it is safe to say that had the Government been permitted to expend the first allotment of $88,000 in building the levee south from Pt. Pleasant, that the work would have been made continuous and the District would have received so much of the other two allotments of $88,000 each to have completed the levee to the State line. Owing to the failure to procure the right-of-way, Capt. Roessler withdrew the contract and proceeded to advertise for bids to construct the levee from Bear Bayou, Arkansas, running north. Bear Bayou, we should have stated, is eighteen miles south of the Missouri and Arkansas State line.

Losing this money convinced the people of Pemiscot County that they must put their shoulders to the wheel. It convinced them that they could not get any Government aid, and if they got a levee they would have to build it. All of our people realizing the importance of levee protection were anxious to go to work. They knew that without a levee the country would have to be abandoned and they would be compelled to leave their little homes, but that with levee protection our district would be the garden spot of southeast Missouri.

The Levee Board met on the 30th day of May, 1893, and made an order submitting to the land holders of the district the question of voting a two per cent tax on the $1.00 betterment on all lands in the district. This was carried by an almost unanimous vote, and the first contracts were let October 10th, 1893. The prices averaged from twelve to fifteen cents per cubic yard, which was a great surprise to the members of the Levee Board, as it was thought that as the contractors could be paid only in Scrip the prices would be higher and the bidders few. There were over two hundred bidders. The bidders were willing to go to work at once and take levee Scrip for pay, but were unable to buy scrapers. The Levee Board succeeded in buying $300,000 worth on a credit. These were turned over to the contractors. Nearly all of our people who failed to get contracts at once began to sub-contract. By the 20th of October between two hundred and three hundred teams were at work on the levee in Pemiscot and New Madrid Counties. Work was continued in proper season until October the following year.

An effort was made to pay off the Scrip. This was not successful, however. In fact an opinion rendered on the legality of the bond issue paid for by the individual members of the Board themselves was that the Board of Directors of the St. Francis District of Missouri could not legally issue bonds. But the contractors finished the work except in a very few places. The total length of the levee thus put up was twenty-seven miles, costing $117,642.

So it will be seen that while the people in Pemiscot County, during the years 1893 and 1894, built twenty-eight miles of levee for which they received $117,642 in levee Scrip, which could not be sold for more than fifty cents on the dollar, our neighbor, the Arkansas District, had their levee built from near Bayou, Arkansas, to the State line, a distance of eighteen miles, by the Government at a cost of over one hundred and fifty thousand dollars.

In August, 1894, the members of the levee board from the Counties of New Madrid and Pemiscot went to Memphis, Tennessee, to urge upon Capt. Roessler the necessity of expending the last allotment of $88,000 of Government money in the State of Missouri. After discussing the matter thoroughly with Capt. Roessler, the members of the board, being ably assisted by the late Capt. H. N. Pharr, who was then the Chief Engineer for both the Missouri and Arkansas Districts, Capt. Roessler agreed to spend the $88,000 in Missouri.

Thirteen miles of levee were built in two contracts, being finally finished in the Spring of 1895. We were left with several miles of unfinished work along our line estimated at about 70,000 cubic yards.

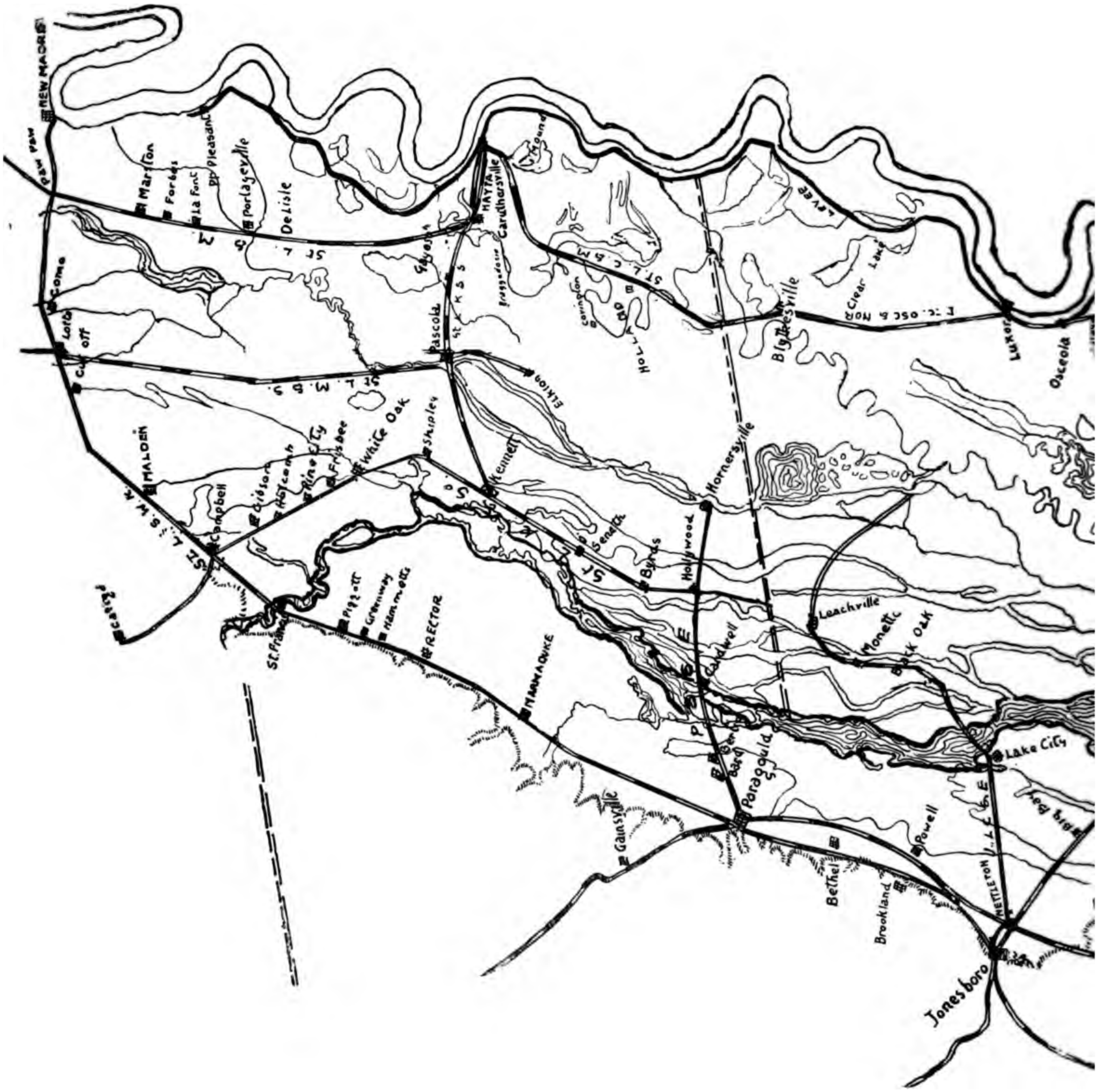
The Legislature of the State of Missouri, in the year 1895, appropriated the sum of twenty thousand dollars to the St. Francis Levee District of Missouri, for the purpose of closing up these gaps and building the Tyler gap and the Gayoso gap. Contracts were let to do this work, or so much thereof as could be done with the twenty thousand dollars. The amount of twenty thousand dollars was not sufficient to do the work, and through the earnest efforts of the late Capt. H. N. Pharr the Board succeeded in procuring an additional five thousand dollars from the then Government Engineer, Capt. Fitch, who had succeeded Capt. Roessler, being a part of the balance on hand of the second allotment of $88,000 made to Arkansas. With this twenty thousand dollars from the State, the five thousand dollars received from the Government and some twenty or twenty-five thousand dollars of Levee Script issued by the Board, the Levee Board succeeded, in the spring of 1896, in finishing the levee from the high lands at Pt. Pleasant, Missouri, to the State line dividing the States of Missouri and Arkansas.

Since the fall of 1893 the people of Dunklin County, claiming that their lands were overflowed from the St. Francis River and not from the Mississippi River, have refused to pay levee taxes, and the members of the Board from that County withdrew or failed to attend any meetings of the levee Board. The Board of Directors of the St. Francis Levee District of Missouri is now composed of William H. Huffman, President; Hina C. Schult, Secretary; Alphonso DeLisle, Treasurer; John A. Cunningham, Dr. J. J. Williams and Jesse DeLisle.

The total cost, including all incidental expenses for building the levee from Pt. Pleasant to the State line, is about $250,000. This levee, when completed, in 1896, had an average height of eight feet with a slope of six to one with eight feet added, and an eight feet crown, with a base of fifty-two feet. In 1897 the levee broke about one mile below the City of Caruthersville, and also broke at Tyler and Cottonwood Pt., Missouri. The Government came to our assistance and rebuilt these breaks for us in the fall of that year. n 1898 the Government spent about $17,000 in strengthening the levees in Pemiscot County. In 1897 and the spring of 1898, a portion of the levee at Pt. Pleasant, Missouri, caved into the river. This is being rebuilt by the Government.

In addition to this, the Government has expended about thirty thousand dollars in strengthening the levee in Pemiscot County from a point at or near Gayoso to the State line. This gives Pemiscot and New Madrid Counties a levee that is fully two and one-half feet above the point reached by the flood of 1897, and absolutely insures protection from inundation by the Mississippi River.

Too much credit for the splendid levee protection that we are enjoying to-day cannot be given to the late Capt. H. N. Pharr, the Chief Engineer of both the Missouri and Arkansas Levee Districts. It was through the earnest efforts of Capt. Pharr that our people became interested in the subject of levees. As far back as the year 1891, Capt. Pharr visited Pemiscot and New Madrid Counties and urged the people to take an interest in the matter of levee building. He saw that by the building of levees along the river front through Missouri and Arkansas, the lands denominated as "Swamp lands" could be reclaimed and made the finest agricultural lands in the world.


NEW MADRID
Paw Paw
Marston
Forbes
La Font
Pt Pleasant
Portageville
Delisle
St. L. M.
Gayoso
MAYTOWN
Caruthersville
Hayti
Braggadocio
Cottonplant
Como
Lotta
Cut off
St. L. M. B. S.
Pascola
St. L. K. & S.
Elkins
St. L. C. & M.
Holland
Blytheville
Clear Lake
LEVEE
F. C. OSC. & NOR
Luxora
Osceola
MALDEN
Campbell
Gibson
Holcomb
Pine City
Frisbee
White Oak
Shipley
Kennett
Senath
Byrds
Hollywood
Hornersville
Leachville
Monette
Black Oak
Lake City
St. L. I. & S. W.
Piggott
Greenway
Hammetts
RECTOR
St. Francis
MARMADUKE
P & E
Caldwell
Paragould
Gainsville
Bethel
Powell
Brookland
NETTLETON
Jonesboro
Big Bay
St. L. I. M. & S.
St. F.

Harry N. Pharr

BRIEF HISTORY OF LEVEES IN THE LOWER ST. FRANCIS LEVEE DISTRICT.

BY HARRY N. PHARR, CHIEF ENGINEER ST. FRANCIS LEVEE BOARD

Office of the St. Francis Levee Board,
West Memphis, Oct. 27th, 1900.

The Lower St. Francis Levee District is that part of the St. Francis Basin lying between the Mississippi River and Crowley's Ridge and extending from the highlands of Big Prairie below New Madrid to the mouth of the St. Francis River, including all of Mississippi and Crittenden counties and parts of Craighead, Poinsett, Cross, St. Francis, Lee and Phillips counties in Arkansas, and all of Pemiscot and parts of New Madrid and Dunklin counties in Missouri. The total area of the district is 3,490 square miles. Its length by river is about 218 miles; its average width is about 25 miles.

The present state organizations were perfected in 1893 and are composed of the Independent Levee Boards of the St. Francis Levee District of Arkansas and the St. Francis Levee District in Missouri, each board being composed of three directors from each county in the district.

At the time of organization the overflows of the previous several years had been very destructive to the levees and the property in the districts, especially those of 1892 and 1893. At this time there existed local protection for a slight area in the vicinity of Osceola afforded by a levee about 22 miles long extending from Bear Bayou to Craighead Pt., built by the U. S. Government to improve the Mississippi River in 1886 and 1887.

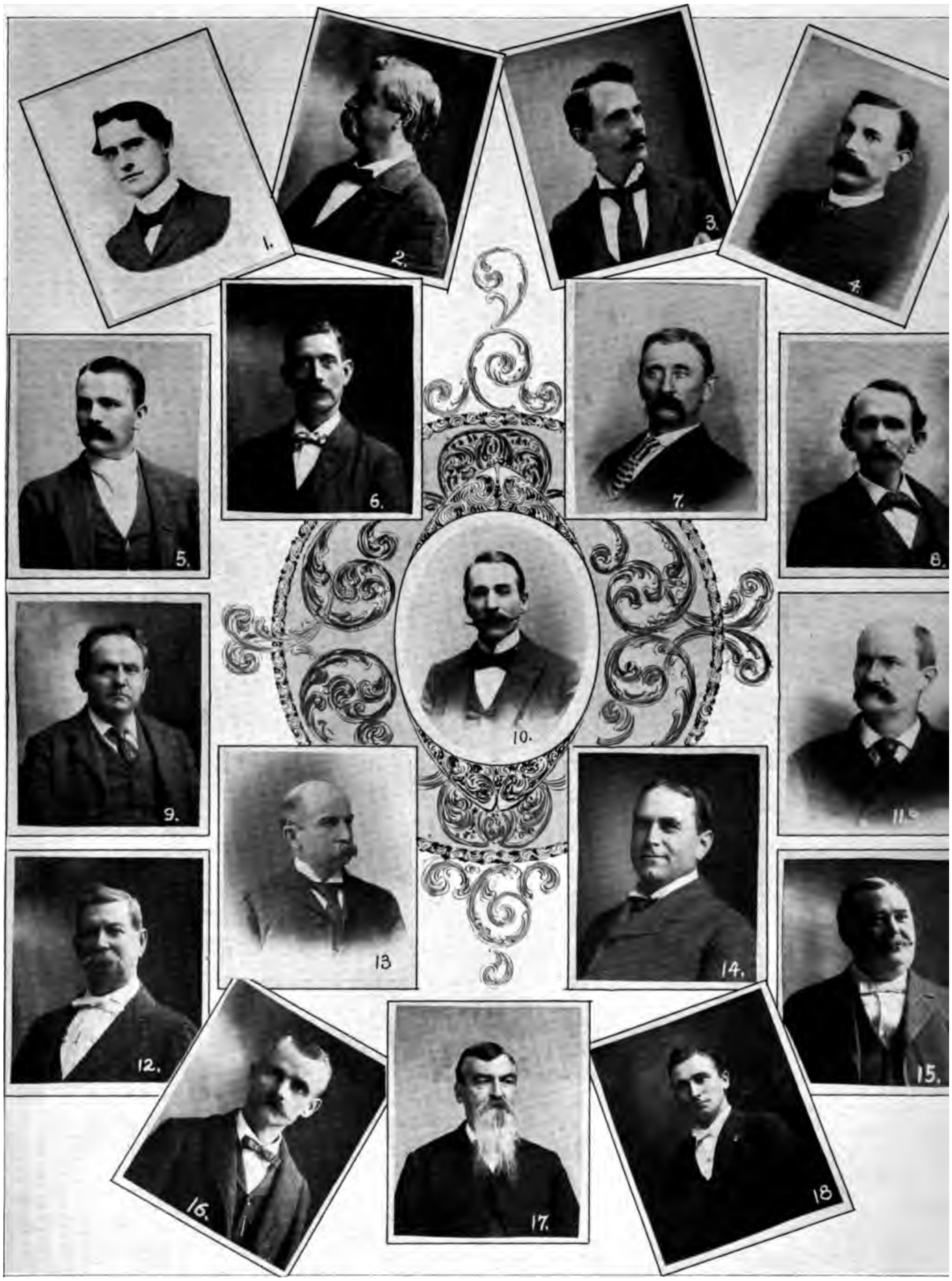
Above and below this levee the water was practically free to escape over the banks into the low lands of the basin. The remnants of the old state levee, long since abandoned, which remained here and there along the whole front of the district, formed no barrier to and retarded but little the general escape of flood water over the bank.

This levee was first constructed by a state organization which was created in 1850 immediately after the passage by Congress of the law donating the swamp lands to the State for levee and drainage purposes. A "Board of Swamp Land Commissioners" was organized to fix the price of the overflowed lands, to district the State, to determine the necessary levees and drains and to let out the contracts to the lowest and best bidders. Under this organization a system of levees was constructed, the few previously constructed private levees being used where possible and absorbed as part of the system. In ordinary years the entire St. Francis Basin was protected from Mississippi River floodwater.

From the Delta survey in the autumn of 1857 and the winter of 1858 the following actual condition of the levee was found to exist:

"From the highlands below New Madrid to the northern boundary of Arkansas the levees were nearly completed. Between the northern boundary of Arkansas and Osceola there were about 2½ miles of unfinished levees. In the bend below Osceola was a gap 1½ miles long. Opposite Island 34 was another gap 1½ miles long. Between Islands 36 and 37 was another 2½ miles long. At the foot of Island 37 was another 4 miles long. At the foot of Island 39 was another 1½ miles long. At the foot of Island 41 was another 3-10 mile long. Six miles below Memphis was another 1½ miles long. In Council Bend, near Island 53, was another 3 miles long. At Walnut Bend, near Island 56, was another 1 mile long. The above list includes the whole St. Francis bottom. By summing up the different gaps it will be found that they were about 25 miles in length.

"It would be a great error to imagine that the bottom was securely leveed with the exception of these breaks. The levees had all been made since the flood of 1851 and consequently had never been tested. They were much too low, hardly averaging three feet in height, although some of them across old bayous were of enormous size, as for



JOHN B. DRIVER, President (center), Mississippi County. 1. W. N. STRAUB, Phillips County. 2. H. P. RODGERS, Lee County.
3. E. L. WESTBROOK, Craighead County. 4. J. T. FULLER, Poinsett County. 5. J. A. EMERICH, Poinsett County.
6. T. H. MAGEE, Lee County. 7. ADDISON HARRIS, Poinsett County. 8. FRANK W. DE ROSSETT, St. Francis
9. S. A. MARTIN, Crittenden County. 11. L. A. FITZPATRICK, Phillips County. 12. JAMES LE VESQUE, Cross County.
13. JAMES FUSSELL, St. Francis County. 14. W. C. DEWEY, Craighead County. 15. J. M. WARD, Mississippi, County.
16. L. W. GOSNELL, Mississippi County. 17. R. D. GRIFFIS, Lee County. 18. O. N. KILLOUGH, Cross County.

ST. FRANCIS LEVEE BOARD IN ARKANSAS

instance a short one near the northern boundary of Crittenden county, which was reported to be 40 feet high, 40 feet wide at the top, and 320 feet wide at the bottom. Generally their cross-section was much too small and upon the whole they were quite inadequate to effect the object for which they were intended."

See Humphrey and Abbot Report, 1861.

The Board of Swamp Land Commissioners was abolished in December, 1856. Another levee act was passed and approved in January, 1857. The Helena District, embracing the counties along the Mississippi River, had already expended its quota of swamp lands and some of the counties were therefore making their own levee laws. There were seven swamp land districts in Arkansas. Within the St. Francis District, organizations existed in Crittenden and Mississippi counties and 10 cents per acre, on cultivated land, was levied for levee purposes. The Boards in each county were composed of three resident land owners.

From 1851 to 1858 there was no considerable overflow; but in the April rise of the latter year several breaks occurred in the levees along the St. Francis front and the maximum rise in June of the same year "washed away miles of the insignificant levees along the St. Francis front and poured rapidly into the bottom lands of that river which were already deeply overflowed from heavy rains and from the crevasses of the April rise. So small was the actual reservoir capacity of that region that the channels of the six large bayous and the St. Francis itself were insufficient to give waterway to the flood returning to the Mississippi. For miles above Stirling it poured over the banks themselves, washing the remains of the levees into the river."

See Humphrey and Abbot Report, 1861.

Another flood of about equal height occurred in March of the following year and found conditions as the previous flood had left them.

The District had not recovered from the effect of these floods at the outbreak of the Civil War, and with the exception of levees constructed by individuals none had been built and no organization existed until the present organization in 1893, when the conditions were as has been stated.

Under the present organizations the tax of four cents per acre is levied on all lands within the districts. With this, together with the lands donated by the State of Arkansas to the District for levee purposes the Arkansas Board has derived an income in excess of $100,000.00 a year, and the Missouri Board an income of about $20,000.00 a year.

Since 1893 the United States Government, through the Mississippi River Commission, has made yearly allotments to assist the Boards in levee construction.

At the close of the present fiscal year there will have been constructed a continuous line of standard levee of 156 miles, extending from the highlands below New Madrid to Scanlan's Landing, Arkansas, about 20 miles below Memphis. There has also been constructed 17 miles in Lee county, Arkansas, extending from Bledsoe to Walnut Bend Landing, and three large drainage canals have been cut.

This has been done at a cost to the Arkansas Board of $1,215,000.00, to the United States Government of $709,284.00, and to the Missouri Board of about $200,000.00, making a total expenditure of $2,124,284.00.

There yet remains to be constructed the gap of 26 miles from Scanlan's Landing to Bledsoe, estimated to cost $612,000,00; and 12 miles from Walnut Bend to the mouth of the St. Francis River, estimated to cost $350,000.00. Also several large drainage canals to cost $200,000.00. The enlargement of the levees already constructed, to the Mississippi River Commission grade, is estimated to cost $1,260,000.00. This total of $2,422,000.00 is the amount estimated as necessary at the end of the present fiscal year for the completion of the lower St. Francis Levees.

E. C. TOLLINGER

THE LEVEES IN THE UPPER TENSAS DISTRICT IN ARKANSAS

BY E. C. TOLLINGER, U. S. ASSISTANT ENGINEER

About all the information we have about the earlier construction of these levees is found in Humphreys & Abbot's Reports, Henson's Book on Levees (published in 1858), in the Federal Government grants of 1848 and 1850, and the several Acts of Arkansas, on file at Little Rock.

The earliest settlements were made on high points along the banks where cut-offs had occurred. Point Chicot was one of these and about the highest land in that section, and from Columbia to Lakeport the overflow was little then (about 1843); the planters were protected by a small levee in front, with side levees running back into the swamp. These levees were built by the land owners. This method was general and was adopted on both sides of the river and afforded partial protection except during great floods.

Better protection was gradually secured as the country developed by securing a more efficient local organization, by aid from the State, and a small amount of assistance in the beginning from the Federal Government.

Humphreys and Abbott state that in 1844 there existed a continuous line of levees from the mouth of the Arkansas River to New Orleans; many of these must have been mere ridges thrown up with a plow, and in a few instances the high points had no levees.

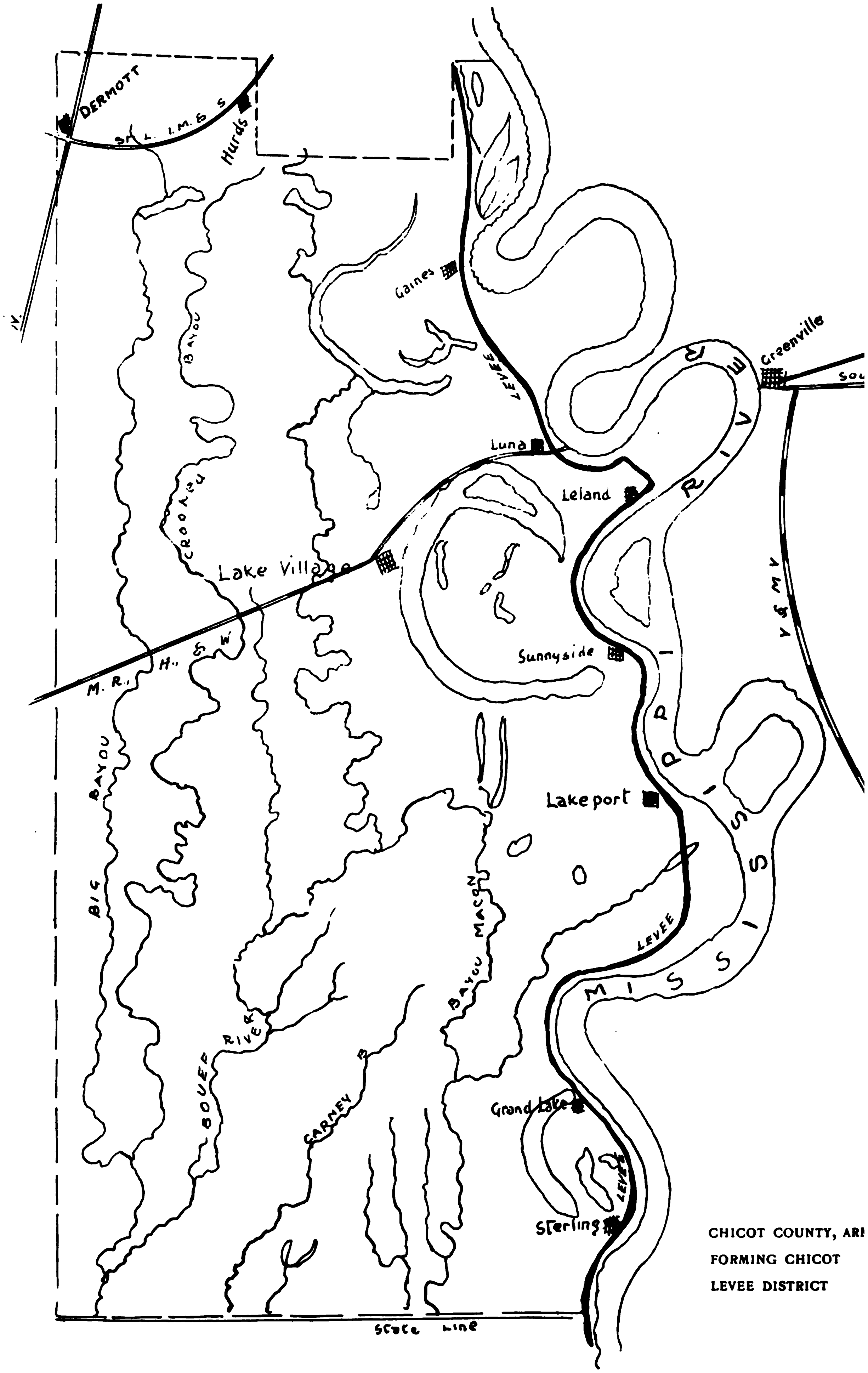
The levees generally were small except where they crossed depressions and bayous. It is not probable that these conformed to any particular standard, but were generally one foot above high water, and five feet base for one in height. The high water of 1844 broke the levees in many places and bankrupted many of the planters, numbers of them leaving the country with their negroes for Texas from this cause.

Under the provisions of the "Swamp Land Act" of 1852, a systematic building of levees was again commenced; the requirements of the law were, a levee thirty inches above the highest known water, seven feet base to one in height, and as many feet crown as the levee was high. From 1852 to 1858 there was much levee work done, and the levee was put in fairly good condition from the mouth of the Arkansas to New Orleans. The line constructed at this time crossed Cypress Creek about 1¾ miles north of Lucca Landing; the drainage of Cypress Creek being down Opossum Fork for a short period. During 1858 there occurred a flood which washed away many miles of levees, and from this time organized effort to maintain the line was abandoned for several years, other crevasses and caving increasing the gaps, leaving the system in a ragged and broken condition.

After the Civil War, there was during the first few years some individual effort made to keep up portions of the levee, but no definite data of this can be obtained. The Chicot County Levee Board was organized in 1886, and the work of closing the crevasses and repairing and enlarging the levees began. This work was paid for by a county tax, and voluntary contributions from citizens.

About this time the Federal Government began assisting in the work and built the line from Boggy Bayou to Matthews Bend, along which front the old line had caved into the river. The levee work done in 1886 and 1887 gave a continuous line from the Amos Bayou Ridge to the Louisiana line, about eighty-six miles. This line had variable slopes, crown and grade line, and successfully resisted the high water of 1887.

Little or no effort was made to clear or grub the ground occupied by the levee until about 1889, the former practice being to cut the trees off at or about two feet above the ground, only a few feet



CHICOT COUNTY, AR
FORMING CHICOT
LEVEE DISTRICT

of berm being left on either side and earth being procured at the most convenient place without regard to depth of borrow pits.

The highest part of Lower Leland was not leveed until 1891-92.

Little of the old construction from 1843 to 1860 now forms a part of the controlling lines; it is generally on the outside of the controlling line, and much of it has caved into the river, or has been abandoned because of faulty construction.

The levees constructed in my sub-district from 1882 to 1890, when not exposed to caving banks, were given 3 to 1 slopes, crown four to eight feet and grade two feet above the highest known water.

The old construction at its best, and this only in very exceptional cases, was 5 to 1 front and 3 to 1 back slope, with a ten foot crown, the major portion of the work being of no regular standard.

Since the systematic construction of the levees has been undertaken in Arkansas by the United States, the section used has been a standard one of slopes 3 to 1, crown eight feet, and grade three feet above the highest known water; exceptions to this standard being made in favor of one as much greater as the occasion demanded in the crossing of water courses, old lake beds, etc. A very careful and thorough revision of the methods of construction has taken place, so those now obtaining are as close as possible to the best practice in the construction of earthen dams. Since these changes there has been no break in levees thus constructed.

This has practically given the Upper Tensas District in Arkansas immunity from overflow since 1894, except from a small break in the Amos Bayou levee in 1897, which damaged only the upper end of this district, but did considerable damage to the Tensas Basin country in Louisiana.

This would indicate that the section for levees now in use is approaching, with proper construction, the correct one, and that the increase of this section to a point sufficiently great to meet the increased height of the flood line expected from the closing in of the basins above will solve the problem, after which a systematic protection of the banks should be undertaken to avoid the destruction of those sections exposed to caving. This should be done now in many places, where the construction of revetment would be cheaper than the renewal of existing works, to say nothing of the property saving incidental.

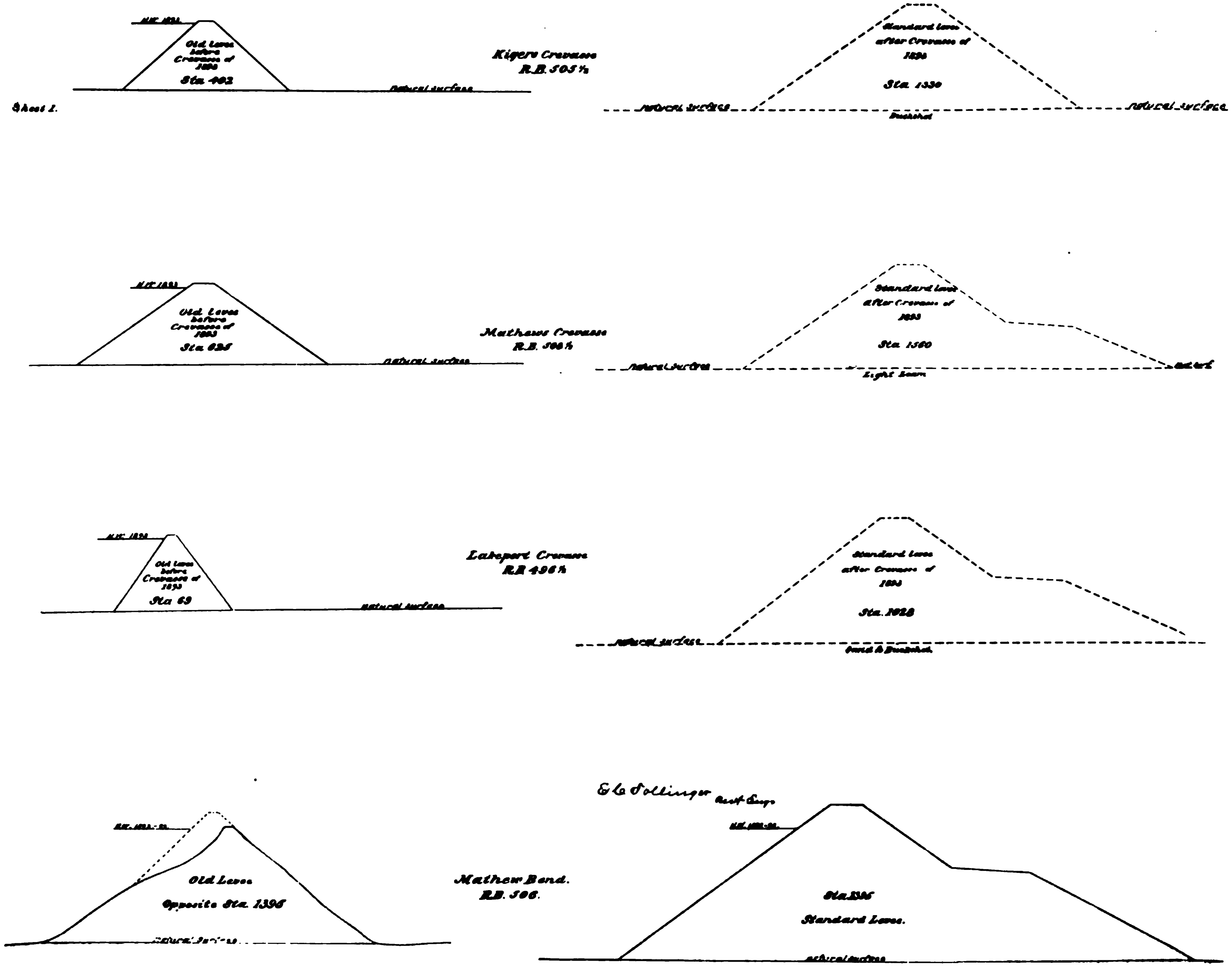
We now know by actual experience, that pure earthen dams built without cover of masonry, puddle or other material, with slopes of five to one and crowns of ten feet, will hold fifty feet or more of water, provided they are well constructed and on a good foundation.

It is to my mind impracticable to secure from the United States, or any other source, sufficient funds with which to complete a permanent line of levees, so long as local interests are allowed to influence their location. The question of damages to the property interests locally affected should be disposed of by legislation in all of the States, such as would tend toward the securing of more permanent locations, at a more reasonable cost. As the cost of rights of way is crippling the local Boards, and in many instances causes, from lack of means, locations known to be injudicious.

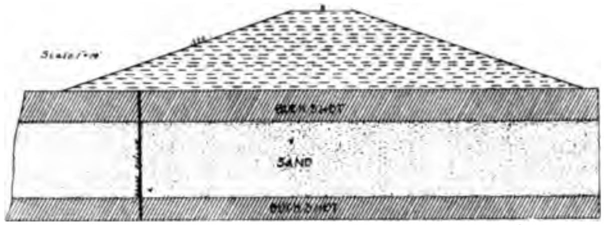
LOUISIANA-TENSAS BASIN

Having only been in charge of this portion of the district about two years, I am not familiar with the early history of levee building in it, but it seems to have been practically the same as in Arkansas, except that a better and more complete system has been enjoyed, since 1884, owing to the policy of the State Government in employing the convicts in the erection of the levees (as an aid to the contract system), and the fact that the area of cultivated land, affected by overflows, is very much greater than in the Arkansas portion of the district, which has afforded a greater tax producing ability.

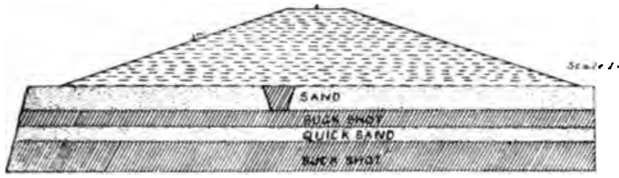
I forward herewith a series of diagrams which explain themselves, showing old sections and present sections in use for levee construction, the comparison of which will readily show the inadequacy of the first efforts at protection from floods as compared with those now in use and proven to be successful so far as completed to the required standard.



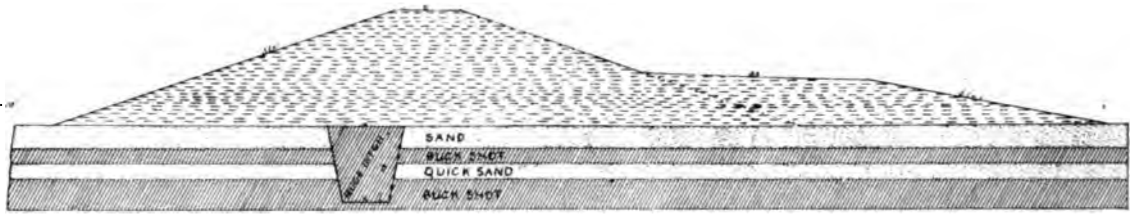
SOME DRAWINGS SHOWING CHANGES IN SIZE AND FORM OF LEVEES.



Section of Levee showing sheet piling



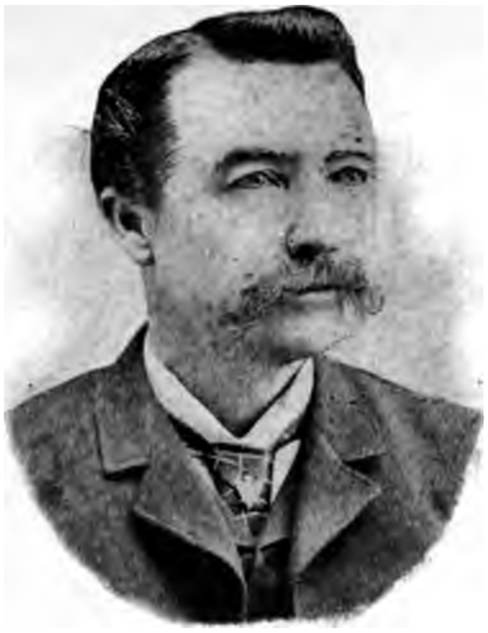
Section of Panther Forest Levee as first built, the foundation proved to be defective during HW 1892-93



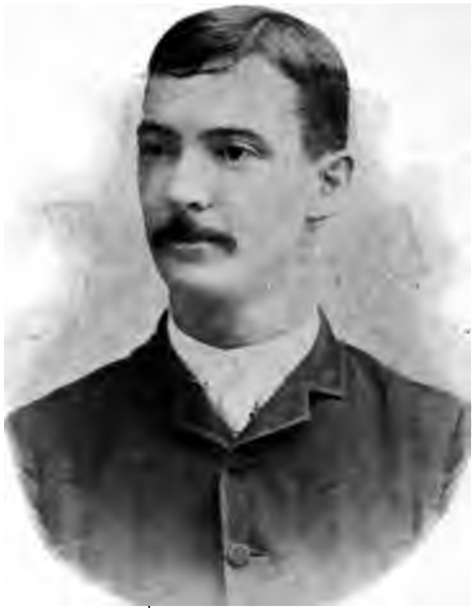
Section of Panther Forest Levee showing method of treating a bad foundation after the HW 1893 that proved very effective during HW of 1897

THE ABOVE ENGRAVINGS SHOW SOME OF THE ADVANTAGES OF DEEP MUCK DITCHES AND STREET PILING

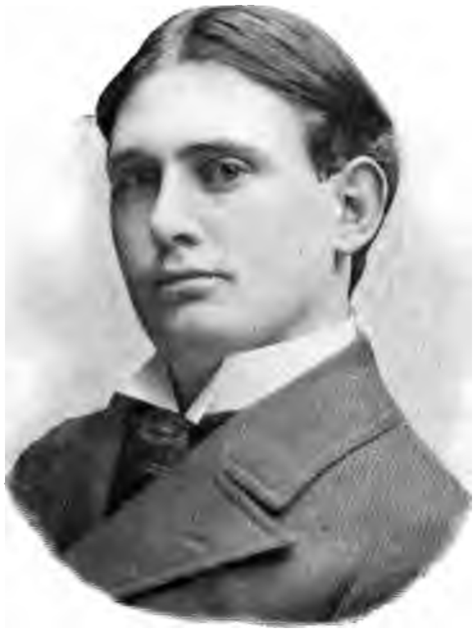
The reader will note that they each sever the sand connection and strengthen by linking the superstructure (levee) with the tenacious buckshot subsoil.—Ed.



R. W. SMITH



GEO. R. LACY



X. O. PINDALL
Attorney

DESHA (ARK.) LEVEE BOARD
Photograph could not be had of Capt. J. M. Whitehill, President.

HISTORY OF LEVEE BUILDING ON THE DESHA COUNTY FRONT

BY CAPT. J. M. WHITEHILL

My experience on the Mississippi River in connection with the levee matters dates back to 1870, when I established a coal business at Arkansas City, which had just been laid out. About this time a railroad company was organized to build a road from Eunice to Monticello and one from Chicora to Pine Bluff, one terminus being four miles below and the other six miles above us. The company tried to buy Arkansas City plantation, but could not secure it and bought instead Chicot plantation on a caving bank. Our people hoped and expected this company to build a levee on which their road should run. There was also negotiations with the people of the Tensas Basin levee district in Louisiana to secure an organization which would build levees in Arkansas to protect their country from overflows leaving the river at the head of Tensas Basin.

The railroad company and the levee interest obtained a bill from the Legislature authorizing the issuance of bonds for $15,000 per mile to build this levee mentioned on which their track should be laid. They pretended to build a levee, sold their bonds, leaving the counties of Desha and Chicot saddled with a debt of $200,000 with no railroad and no levee. The wrecking of the scheme was hastened by yellow fever and cholera which wiped out the town of Chicot.

The levee agitation was continued by Col. G. W. Sapington and others, but never was accomplished until 1883, when a subscription fund of $47,000 was raised. The State of Louisiana contributed $25,000 of this of the State funds. The Tensas Basin district had no power at that time to build levees in Arkansas. At that time I became President of the Desha levee district. Contracts were let and the $47,000 was expended. The water came up and the Mississippi River Commission gave us $10,000 to hold what levee we had, which, however, partly washed away.

In the summer of 1884 we resumed the work with renewed vigor to raise the levee a grade of one foot above the 1882 flood.

Major Starling, the engineer, and myself, obtained our high-water mark from the trees. Right here I will say that our present grade of three feet above the 1897 water is at least eight feet higher than the marks which we used in 1884. To accomplish this increased re-building, which involved a total of 300,000 yards, a subscription of $50,000 was raised, the Commission, through Captain Rossell, agreeing to contribute $25,000, provided we could raise the balance to finish the work and give good bond to complete it. After canvassing the situation we found no contractor willing to bid a reasonable price and take a subscription list for pay.

Major John D. Adams and myself, being large land owners, organized with a few others a joint stock company to build the levee and were awarded the contract at 24 cents per yard. The work covered a distance of seventeen miles, constituting the enlarging of old levees and the closing of old gaps.

One remarkable thing I may mention is that Opossum Fork levee across the bayou had stood all through the four years' war without being destroyed. This levee is fifty feet high.

We had high water in 1885 which ran through our work and Capt. Clinton B. Sears and Assistant Clayton G. Coleman spent a part of the $25,000 trying to secure ends of levees. We finished our contract in March and received a receipt from Captain Sears and Major Richardson, but we could not collect all the individual subscriptions. In fact Major Adams and myself together lost over $18,000. We consoled ourselves that, although we had made such a loss, we had accomplished the salvation of the country.

In 1886 we were overflowed from back-water through the Arkansas River, caused by local levees giving away. In 1886 we received an allotment of $87,000 to close the breaks and do some enlargement. Under the supervision of Captain Rossell in 1887 we were saved by the Mississippi River Commission coming to our relief with money, sacks and other material. Captain Rossell and his assistant, Capt. E. C. Tollinger, were in charge of the Government and their management cannot be too highly complimented.

In 1886 the Arkansas River levees were allotted $60,000 by the Commission and the Tensas Basin people built these miles of levee from Amos Bayou to Costello Gin. We had no break in 1897 and feel that our levees are measurably secure.

I am often asked the question whether the river is filling up, and my answer is, No. The facts are about these:

I have been familiar with the gauge since its establishment and always dictated where to put 0. It came within one-tenth of 0 before we commenced to hold the levees, but never below until October 9, 1895, when it went 0.2 below; November 10, 1895, 3.3 below, which is the lowest ever known. It remained below until December of that year.

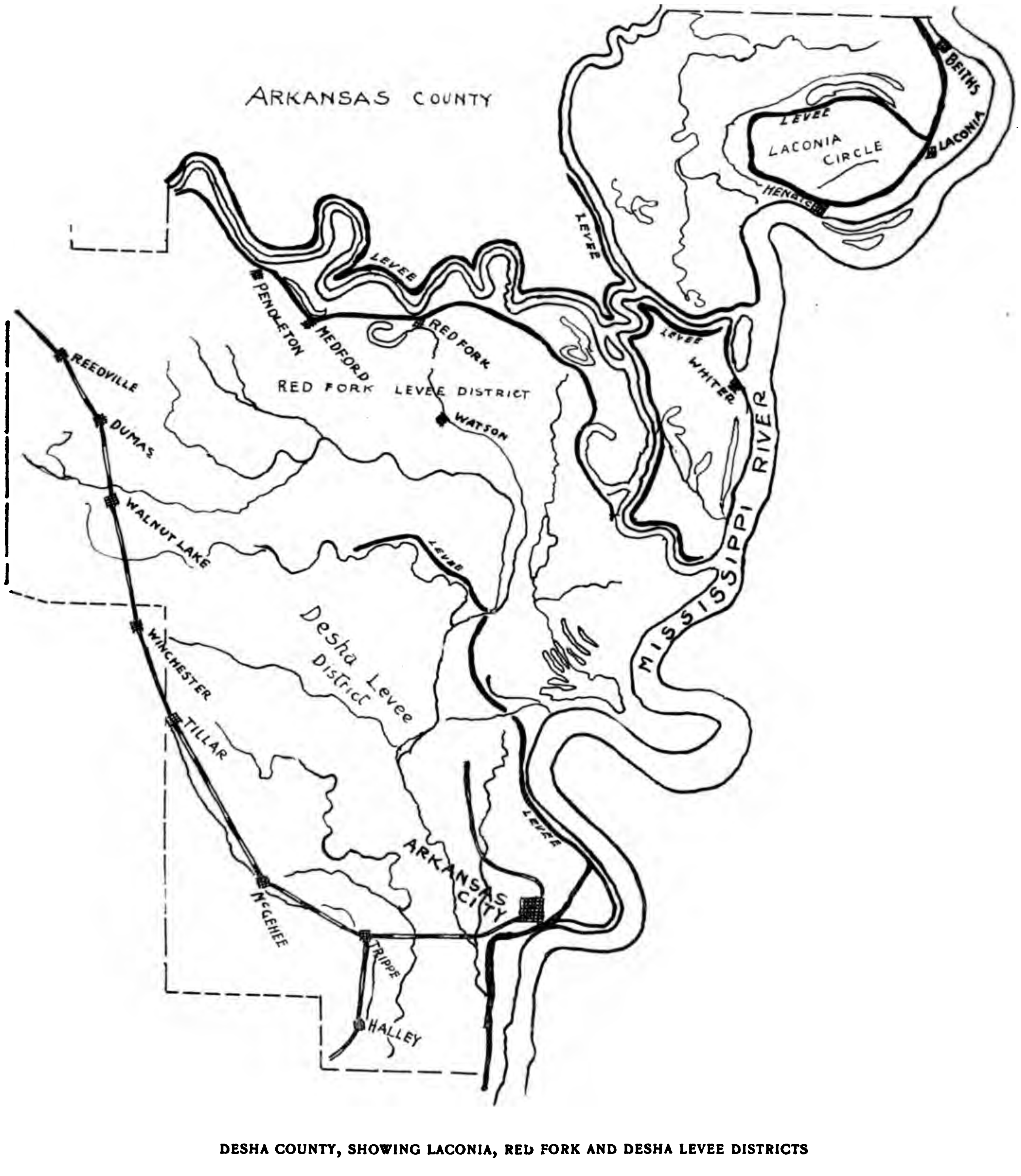
In 1897, on October 27, it went 2.3 below 0 and remained there for four days. You will note that 1897 was the highest water and next to the lowest reading ever known on our gauge. At very low water in the early seventies it was a common thing to see from three to five boats in trouble on the river. Since we commenced holding the levees there has been no such trouble at Choctaw or Catfish Points.

These are things that have come under my own observation. I have been a pilot and have been handling boats over these places since 1870 and have lightered many a boat over these bars.

On October 13, 1899, the gauge stood 2.3 at Arkansas City, yet steamboats drawing five feet of water had no trouble in plying the river. This should convince the most skeptical that the channel is cutting out instead of filling.

I am fully in accord with the present system of levee and channel improvements.

MAKING WILLOW MATTRESS



DESHA COUNTY, SHOWING LACONIA, RED FORK AND DESHA LEVEE DISTRICTS

X. J. PINDALL

M. W. QUILLING

A. WYNNE
President

RED FORK LEVEE BOARD DESHA COUNTY, ARK.

THE RED FORK LEVEE DISTRICT

BY G. E. BUCK, SECRETARY

The Red Fork Levee District in Desha County, Arkansas, was established by act of the State Legislature in 1891. It is composed of the political townships of "Silver Lake," "Red Fork" and part of "Old River" and Wilkerson, embracing an area of about 250 square miles, fronting on Arkansas River from the line between Lincoln and Desha counties south to the mouth, thence south on the Mississippi River to the mouth of Cypress Creek, a distance of about 40 miles front on the two rivers. The affairs of the district are managed by three inspectors, elected every two years by a majority of the land holders in the district. The tax levied is limited to 2 per cent on the assessed valuation of the land in the district. This tax is collected by the sheriff or collector of the county and turned over to the treasurer of the district.

The act of the Legislature establishing the district appointed G. E. Buck, J. T. Sledge and A. Wyman inspectors. They organized June 13, 1894, electing G. E. Buck president of the Board of Inspectors, Frank Nady treasurer, and V. R. Ryan, secretary. This Board of Inspectors served till October, 1892, election, and were succeeded by G. E. Buck, Frank Nady and W. M. Cardes and organized Nov. 4, 1892, electing G. E. Buck president, X. J. Pindall treasurer and R. M. Blakeman secretary. This board was succeeded October, 1894, by the election of A. Wynn, W. A. Cheshire and M. W. Quilling, and at the organization, A. Wynn was elected president, X. J. Pindall treasurer and G. E. Buck secretary. This board has succeeded itself the last two elections and are the present incumbents. Recent acts of the State Legislature donated all the State lands within the county (not embraced in other levee districts) to this district, the sales of which have added materially to the revenues of the district. The total revenues received by the district from all sources since its organization are $37,866.41; have received in contributions to levee building from the Texas Basin District in Louisiana $15,000; from the Chicot County District in Arkansas, $12,000; from the Desha Levee District in Arkansas, $3,000, and from the general government about $100,000. It has erected about 16 miles of new levees and about 150,000 cubic yards of enlargement and loop work. The district has successfully maintained its line of levees from the ravages of floods, but as yet the levees are far from adequate for the purpose. Fifteen miles of enlargement work on Arkansas River above Red Fork will have to be accomplished, at a cost approximately of $50,000, and some eight miles of new levee yet on the Mississippi River at a cost approximately of $100,000, before protection from floods will be given.

A secure line of levees is of great importance here, as this district lies at the head of what is known as the Tensas Basin and overflows affect lands in the Chicot and Desha Districts in Arkansas, and the Tensas District in Louisiana.

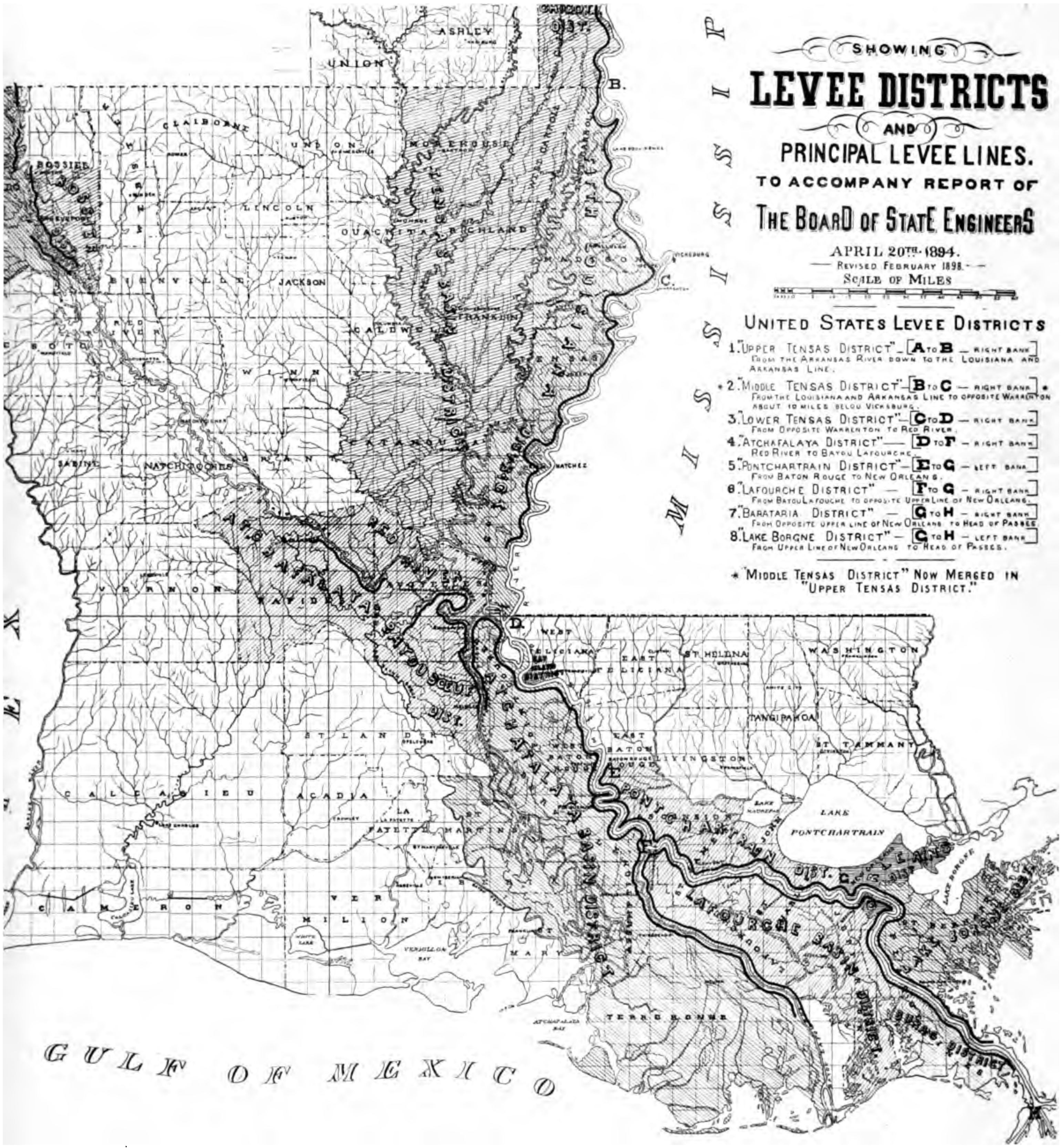
E. D. PILLOW
President

J. T. BRAME

C. H. PURVIS
Chief Engineer

GREENFIELD QUARLES

BOARD OF COMMISSIONERS, COTTON BELT LEVEE DISTRICT, ARKANSAS


SHOWING
LEVEE DISTRICTS
AND
PRINCIPAL LEVEE LINES.
TO ACCOMPANY REPORT OF
THE BOARD OF STATE ENGINEERS
APRIL 20TH. 1894.
— REVISED FEBRUARY 1898. —
SCALE OF MILES
UNITED STATES LEVEE DISTRICTS
1. "UPPER TENSAS DISTRICT" – [A TO B – RIGHT BANK] FROM THE ARKANSAS RIVER DOWN TO THE LOUISIANA AND ARKANSAS LINE.
* 2. "MIDDLE TENSAS DISTRICT" – [B TO C – RIGHT BANK] * FROM THE LOUISIANA AND ARKANSAS LINE TO OPPOSITE WARRENTON ABOUT 10 MILES BELOW VICKSBURG.
3. "LOWER TENSAS DISTRICT" – [C TO D – RIGHT BANK] FROM OPPOSITE WARRENTON TO RED RIVER.
4. "ATCHAFALAYA DISTRICT" — [D TO F – RIGHT BANK] RED RIVER TO BAYOU LAFOURCHE.
5. "PONTCHARTRAIN DISTRICT" – [E TO G – LEFT BANK] FROM BATON ROUGE TO NEW ORLEANS.
6. "LAFOURCHE DISTRICT" — [F TO G – RIGHT BANK] FROM BAYOU LAFOURCHE TO OPPOSITE UPPER LINE OF NEW ORLEANS.
7. "BARATARIA DISTRICT" — [G TO H – RIGHT BANK] FROM OPPOSITE UPPER LINE OF NEW ORLEANS TO HEAD OF PASSES.
8. "LAKE BORGNE DISTRICT" – [G TO H – LEFT BANK] FROM UPPER LINE OF NEW ORLEANS TO HEAD OF PASSES.
* "MIDDLE TENSAS DISTRICT" NOW MERGED IN "UPPER TENSAS DISTRICT."
MISSISSIPPI
GULF OF MEXICO
ASHLEY
UNION
CLAIBORNE
MOREHOUSE
BOSSIER
LINCOLN
OUACHITA
RICHLAND
BIENVILLE
JACKSON
MADISON
VICKSBURG
B.
C.
D.
E.
RED RIVER
DE SOTO
CALDWELL
FRANKLIN
TENSAS
WINN
CATAHOULA
NATCHEZ
SABINE
NATCHITOCHES
GRANT
RED RIVER
VERNON
RAPIDES
AVOYELLES
WEST FELICIANA
EAST FELICIANA
ST. HELENA
WASHINGTON
TANGIPAHOA
ST. TAMMANY
ST. LANDRY
POINTE COUPEE
WEST BATON ROUGE
EAST BATON ROUGE
LIVINGSTON
CALCASIEU
ACADIA
LAFAYETTE
ST. MARTIN
IBERVILLE
ASCENSION
LAKE PONTCHARTRAIN
LAKE MAUREPAS
CAMERON
VERMILION
IBERIA
ST. MARY
TERREBONNE
LAFOURCHE
LAKE BORGNE
VERMILION BAY
ATCHAFALAYA BAY
WHITE LAKE
FIFTH DIST.
TENSAS BASIN
ATCHAFALAYA
BAYOU SCIUT DIST.
PONTCHARTRAIN DIST.
LAFOURCHE BASIN
ATCHAFALAYA BASIN DISTRICT
BARATARIA DISTRICT
LAKE BORGNE DISTRICT
BUCHANAN DISTRICT
ORLEANS

LOUISIANA LEVEE DISTRICTS

Henry B. Richardson

LOUISIANA LEVEES

BY HENRY B. RICHARDSON, CHIEF ENGINEER OF LOUISIANA

For untold ages the waters from an area of nearly a million and a quarter square miles, draining through countless minor channels, have gathered in the Mississippi river and its tributary streams, and found their way through Louisiana to the sea. The finer soils and fertilizing elements of this vast territory have been washed from its surface, separated and selected from its poorer constituents, borne along with the currents to the main stream, and finally deposited in the alluvial valleys, building up a broad expanse of land of unparalleled richness. Louisiana's share in this grand alluvian includes upwards of 15,000 square miles, or fully one-third the area of the State.

In a state of nature, before the advent of civilized man, the alluvial valleys were covered by luxuriant forest trees and dense cane-brakes. They were also covered during the freshets of every Spring, with the overflowing waters of the rivers. As the waters rising from pouring rains and melting snow in thousands of distant brooks and branches, gathered into mighty floods and swept down the Mississippi and the Red, they generally overtopped the river banks in many places, and flowed in a thin sheet over the adjacent land. The thick undergrowth, by checking the rapid flow of the escaping muddy water near the banks, permitted the earth and sand held in suspension and carried along by the current to settle, and thus continually built up the banks. But the stronger currents in the rivers themselves as constantly wore away and cut back the banks, into lower ground in some places, so that the work of building up and tearing down was forever going on—as, indeed, it still is—and consequently the river banks throughout their length were never built quite up to high water mark by the unassisted processes of nature.

Thus it was that when the earliest settlers began to open plantations along the water courses of the alluvial valleys, they soon found it desirable for comfort and convenience if not absolutely necessary for rendering the country habitable, to keep the flood waters from flowing across the river banks and over their clearings and plantations. The most obvious and natural means for preventing such overflow was, of course, to make the banks a little higher with a ridge of earth. Such a ridge, or levee, a few inches, or at most a few feet, in height, was usually sufficient to protect the immediate front against ordinary floods, and was not a work of great cost or labor. The lower lands back from the river might still be inundated, but this was of little consequence while there was plenty left on the front.

The engineer, De la Tour, who laid out New Orleans in 1717, found it necessary to provide for a levee something over a mile in length to be raised in front of the city to preserve it from overflow, which, however, appears not to have been completed until ten years later, when levees were being built by the riparian owners for a distance of eighteen or twenty miles above and below the city. It required another hundred years to extend the levees up to the mouth of Red river, though by that time (1828) there were some disconnected and unfinished levees on the west bank of the Mississippi as far up as the mouth of the Arkansas, and some progress had been made in levee building on the upper Lafourche. All of these earlier levees were so small and low as to be frequently overtopped and broken by the floods. Their proportions, compared with those of the levees of to-day, appear almost absurdly insignificant. As late as 1851 the levees between New Orleans and Red River Landing, from actual measurements made by the United States Delta survey, were found to have an average height of only 4 1-2 feet, the largest not exceeding 8 feet in height, nor 32 feet in width of base.

From these small beginnings the levee system of Louisiana has been evolved to its present condition, and its future evolution seems destined to continue.

The grant made by the Federal Government in 1850 to the several states of all unsold swamp lands within their limits, to provide funds to reclaim the alluvial region below the mouth of the Ohio, gave impetus to the work of levee building. Also, some years before the war between the states, a levee district had been formed of the alluvial lands in Carroll, Madison and Catahoula Parishes, with commissioners empowered to levy taxes on the two former parishes for levee purposes; and the police juries of Tensas, Concordia, Rapides, Ouachita and Pointe Coupee had been given power by the legislature to raise funds by taxation for building and repairing their levees. But otherwise the burden of levee construction and maintenance remained until after the war, as it had been from the beginning, a servitude upon the lands of the riparian proprietors.

During the four years of war the levees were greatly neglected, so that by 1865 they were breached in many places and in a general condition of disrepair and inefficiency. Efforts were made during the so-called "period of re-construction" to restore and repair the levees; but high prices, the magnitude of the work required and the general disorder and uncertainty of political and financial affairs prevented any decided improvement. Work was carried on under a State Board of Levee Commissioners, under a Board of Public Works, and by a contract with the Louisiana Levee Company. But although some 20,300,000 cubic yards of earthwork was put upon the levees at a cost of about $11,000,000, between 1865 and 1877 (when the government of the state came again into the hands of her own people), the condition of the levee system was hardly better than it had been twenty years before. The levees in Desha and Chicot counties, Arkansas, upon which north Louisiana is as dependent for protection as upon her own, were broken and destroyed along almost every bend of the river, while at home the great crevasses at Ashton, Diamond Island Bend, Morganza and Bonnet Carre had remained wide open for years, and many miles of levees existed which, on account of lack of means, had been built with grades known and designed to be 3 and 4 feet lower than the level of previous high water.

It has been fortunate for Louisiana that her chief executives, ever since 1877, have been men who, each in turn, might be justly and appropriately called "the levee governor." Their active interest in levee improvement and wise influence upon legislation to that end have encouraged our people to perseverance, and have been largely instrumental in securing the enactment of the laws under which the levee affairs of the state are now administered. The alluvial valley has also been fortunate in the composition of the United States Mississippi River Commission. The oldest member of that body—indeed, the only one who has served on it continuously since its creation in 1879—has been a persistent and cogent advocate of levee work on the Mississippi river, both as a means of improving its channel for navigation and to prevent the ravages of destructive floods. His influence upon the views of the commission has been manifest since 1882, when it made the first allotment of funds for levee work.

There are now thirteen levee districts incorporated under state laws, covering nearly all the alluvial territory of the State. They have boards of commissioners, varying from three to nine in number (there are eighty-two of them all told), empowered to levy taxes and local assessment, to issue bonds, and, generally to do whatever is necessary to construct and maintain levees for the protection of their several districts. The Fifth Louisiana and Tensas Basin levee districts were created in 1886; the Red river, Atchafalaya and Bayou Boeuf district, the Orleans district, the Pontchartrain district, and the Atchafalaya Basin district, in 1890; the Lafourche Basin district, the Lake Borgne Basin district, the Caddo district and the Bossier district, in 1892; the Buras district and the Cat Island district, in 1894; and the Grand Prairie district, in 1898.

These districts have been organized with a view to local independence; that is to say, they are generally susceptible of protection against overflow by levees located entirely within their own territory. The Tensas Basin district is an exception to this condition, being subject to overflow mostly by water leaving the Mississippi river in the State of Arkansas; and hence its principal function has been to aid in the building and improvement of levees outside its own boundaries and in another state. The board of state engineers are, ex-officio, the engineers and advisers for the levee boards of all these districts except the Orleans district, in which their duties are limited to the approval or disapproval of levee locations on the river front.

The assessed valuation of the thirteen levee dis-

MARSHALL P. ROBERTSON
Assistant Engineer

WALTER H. HOFFMAN
Secretary of the Board

H. BOLIVER THOMPSON
Assistant Engineer

LOUISIANA STATE BOARD OF ENGINEERS

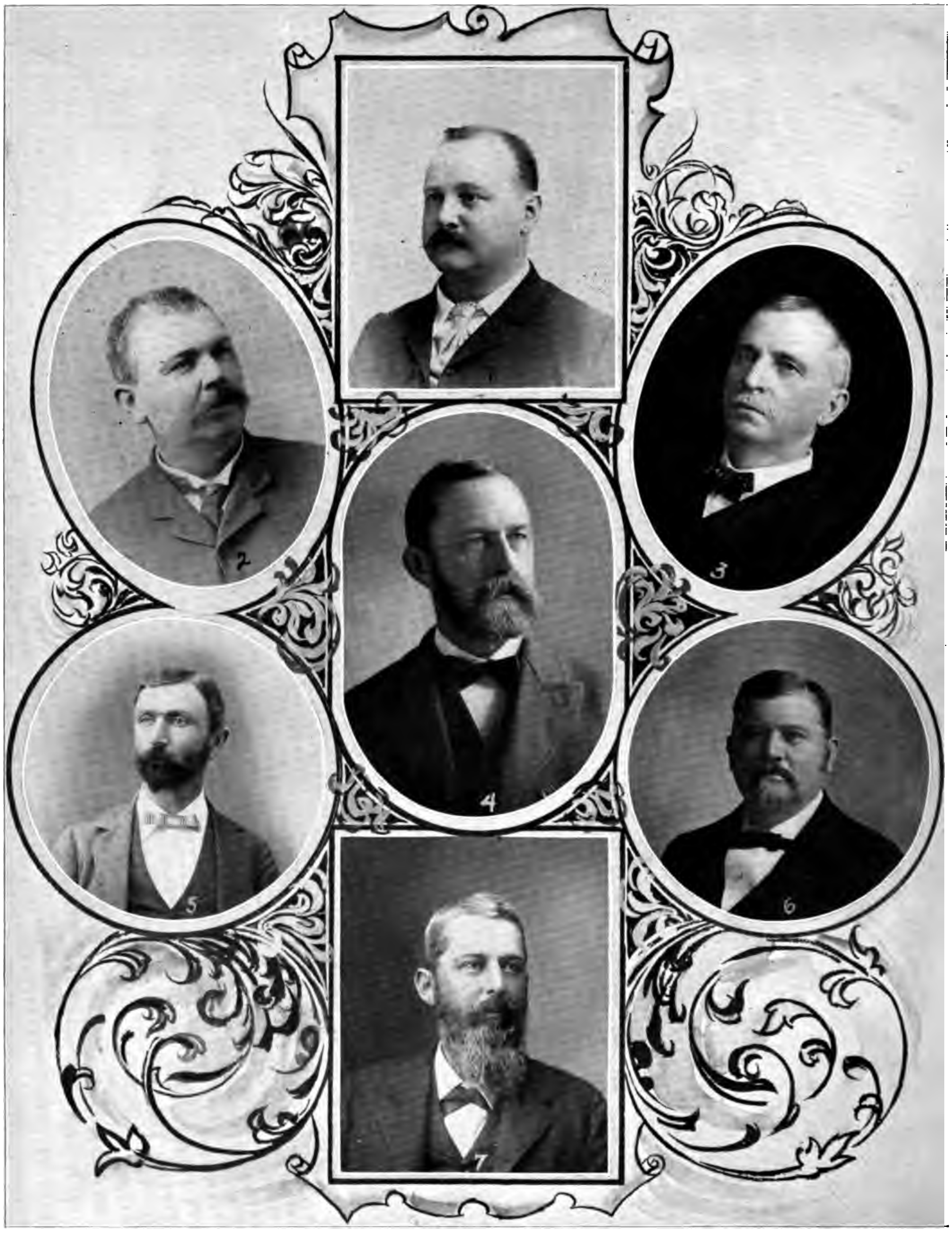
☞Engraving of Maj. Henry B. Richardson, Chief State Engineer, appears at the beginning of the paper which these engravings accompany.

Engraving of Arsene Perriallat, Assistant Engineer, appears with Atchafaloya Levee Board.

THE LATE M. JEFF. THOMPSON
Former Chief Engineer of Louisiana

SIDNEY F. LEWIS
Assistant Engineer

FRANK M. KERR
Assistant Engineer



1. E. J. HAMLEY. East Carroll. 2. G. C. GOLDMAN, Tensas. 3. C. C. CORDILL Tensas. 4. J. T. M'CLELLAN, Madison.
5. W. H. WARD, Madison. 6. W. H. BENJAMIN, East Carroll. 8. J. H. LAMBDIN, Concordia.

THE FIFTH LOUISIANA LEVEE BOARD

tricts upon the state tax rolls, aggregates about $181,000,000; and their gross annual revenues are estimated at about $1,000,000. Their aggregate bonded indebtedness, in April, 1900, was $3,581,200.

In addition to the revenues of the levee districts, the proceeds of a 1-mill tax throughout the State are available for levee work. Its estimated annual amount, after allowances for delinquencies and expenses of collection and administration, is about $150,000.

The great flood of 1882 caused such destruction of levees and widespread overflow that a general feeling of discouragement pervaded the people. It appeared likely that a considerable part of the flooded country would be deserted by its owners and occupants, and that efforts to restore and maintain the levees might be abandoned, or, at least, indefinitely postponed. But in August of that year the Mississippi River Commission made its first allotment for levee building from the funds placed at its disposal for the improvement of the river, and new levees were built by the United States, closing most of the crevasses which had occurred during the flood of 1882. This gave new hope and courage to our people at a critical moment, and the work of improvement has not flagged, nor public confidence abated at any time since, although there has been no lack of disaster and of destructive overflow in a number of flood years following. The Mississippi River Commission has made allotments for levee work from time to time as appropriations were voted by Congress, the aggregate expenditures for this work in Louisiana and in that part of Arkansas which is of equal importance to us, having thus far been about $9,600,000.

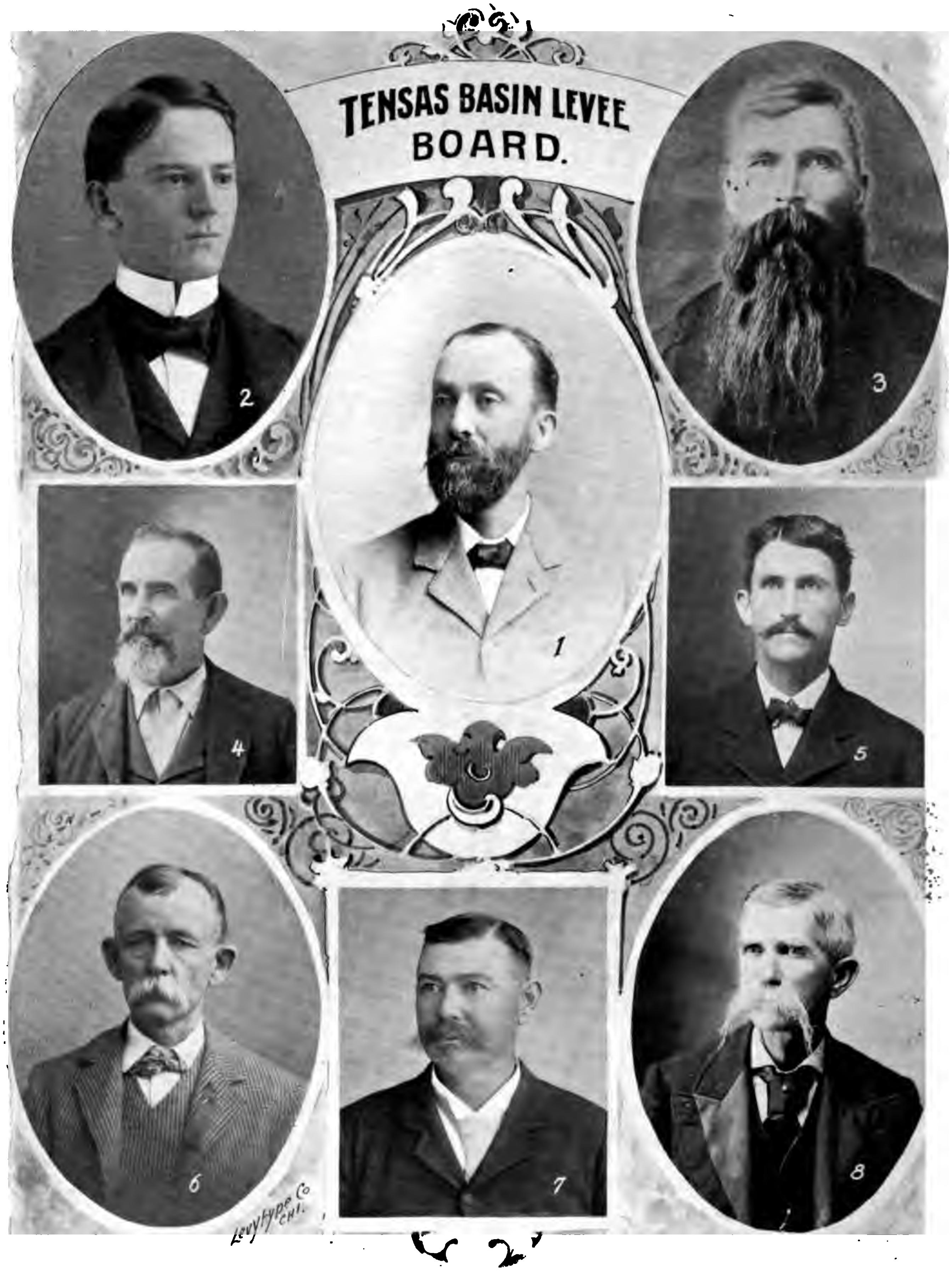
The actual cost of levee work done by the State of Louisiana and its several levee districts, within the state and upon the Arkansas levees upon which she is dependent for protection, has aggregated since the close of the war in 1865, so far as records have been preserved, about $23,345,000. This is exclusive of the large and mostly unrecorded amount of work done upon the public levees (the greater part previous to the organization of the levee districts) by parochial and municipal authorities, by corporations and private parties, and does not include expense of administration, nor discount or interest paid by the several levee districts on bonds or other debts. It is also exclusive of the cost of most of the wooden revetments and other protective works, and of all "high water expenses" such as sacks, lumber, freight, guards, laborers, etc.

The levee system on the Mississippi river is now continuous on the west bank from Amos Bayou, in Desha county, Ark., to Bougere Landing, in Concordia parish, about twenty-six miles above the mouth of Red river, a length of levee of about 302 miles and, except the opening into Bayou Lafourche, from Barbres Landing, at the head of the Atchafalaya river, to The Jump, a length of about 295 miles. On the east bank it extends from Baton Rouge to Fort St. Philip, a length of about 211 miles.

The principal levee lines on interior streams are as follows: On the west bank of Red river, from above Scott's Slough to Eric's Point, about 34 miles; from Bayou Pierre to Stringfellow's, about 38 miles, and from two miles above Alexandria on Bayou Rapids to David's Ferry, about 37 miles; on the east bank, from Hurricane Bluff to Ninock Lake, about 58 miles; on Bayou des Glaizes and the west bank of Atchafalaya river, from the junction of Little des Glaizes, to Melville, about 73 miles; on the east bank of Atchafalaya river, from Barbres Landing to Mussel Bayou, about 34 miles; and on Bayou Lafourche, both sides from its head at Donaldsonville nearly 75 miles down the bayou, a length of levee of about 149 miles.

Besides the levee lines above mentioned there are numerous short pieces of levee and detached dikes on the banks of the Red, Ouachita, Black, Tensas and Little rivers, etc., as well as public levees in the rear of New Orleans, making the aggregate of Louisiana levee lines approximate a length of 1329 miles. Add to this the 85 miles of levee in Arkansas upon which Louisiana is dependent for protection, and we have 1414 miles of levee line that may be considered as belonging to the levee system of Louisiana. The levees along the southwest bank of the Arkansas river also have some share in protecting Louisiana against overflow from that stream, and from time to time this State has contributed funds for their repair and maintenance.

The present height and section of the levees above described, and their margin above high water, varies in different localities. While in a general way it has been attempted to build nearly all of them up to a height not less than three feet above the highest flood levels, before undertaking



MEMBERS — 1896-1900

1. **JOHN P. PARKER**, President; Ouachita Parish. 2. **J. L. BORDEN**, Secretary. 3. **W. A. COLLINS**, Morehouse Parish.
4. **J. Q. GRAVES**, Caldwell Parish. 5. **J. A. HEMLER**, Richland Parish.
6. **R. E. YANCEY**, Catahoula Parish. 7. **W. C. BUCHANAN**, West Carroll Parish. **E. M. HICKS**, Franklin Parish.

JOHN DYMOND

President Lake Borgne Basin Levee Board

THOS. J. KERNAN

Attorney Pontchartrain Basin Levee Board

W. I. BARHAM

Member of Tensas Basin Levee Board (appointed 1900)

W. H. HOLLOMAN

Member Tensas Basin Levee Board (appointed 1900) their enlargement to a final grade and section, there remain many miles of the various systems that are still scarcely higher than the high water plane of previous great floods. On the Mississippi river, as far down as New Orleans, their actual height now probably averages over twelve feet, though there are many long stretches over twenty feet in height. Towards the lower end of the system their height gradually diminishes, so that in the Grand Prairie and Buras districts they will only average about five or six feet. On the Red and the Atchafalaya, a fair average height is probably nine to ten feet, though from the irregularity of the ground the heights are quite variable. On Bayou Lafourche the average height of existing levees is probably as much as twelve feet. There are many dikes across sloughs or bayous, mostly on the Red and Atchafalaya and on the Mississippi above the mouth of the Red, of great height—some of them over forty feet.

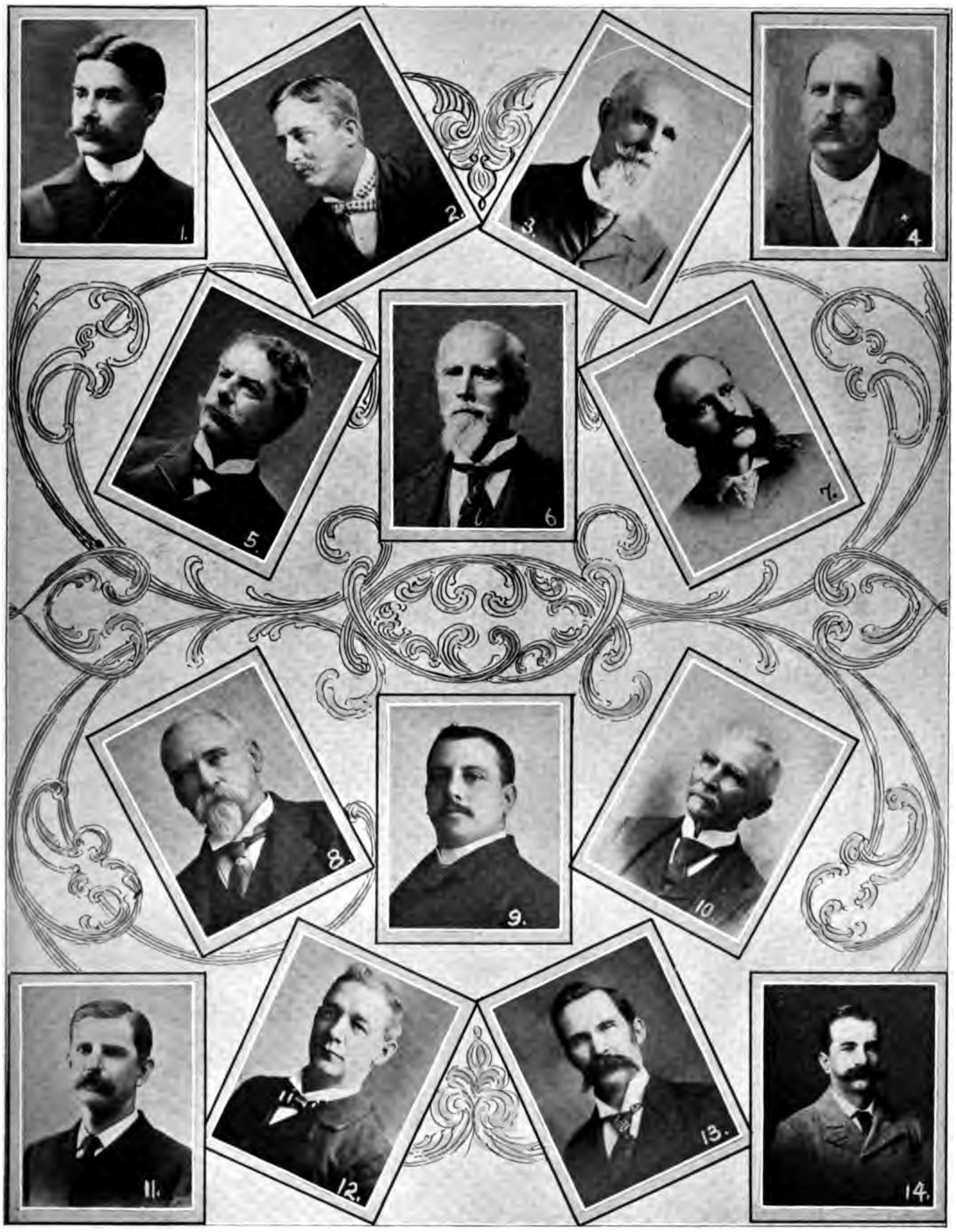
The cross-section of the existing levee line also varies as greatly as its height, though nearly all the levee work of the past ten or fifteen years has been designed to have side slopes not steeper than two feet horizontal to one vertical, and the width of crown has been usually as much as eight feet for the larger levees, but there are many exceptions. A considerable length of levee has also been built with a "banquette" on the land side, giving it a greater width of base.

The total contents of the controlling line of public levees in Louisiana and that part of Arkansas in which she is directly interested, is roughly estimated at about 112,000,000 cubic yards of earth. Taking the average price for which levee work has been done by the State of Louisiana during the past two years at a little under fourteen and a half cents per cubic yard, we should find the money value of these levees to be about $16,000,000. It does not follow, however, that they could be built de novo for any such sum, though there can be no doubt that the work would be done now and hereafter for much less than it originally cost. This lowering of prices has been brought about largely by the substitution of mule teams with scrapers for the old-time Irishman with a wheelbarrow, but competition consequent upon the larger quantity of work offered has also had much to do with the reduced cost.

Sixteen million dollars worth of work put into levees—or, indeed, two or three times that much, should not appear an extravagant investment, considering the magnitude of the interests involved. But there is another way of looking at the matter, which has been too much the fashion, even with our own people, who best know—as they have learned from experience—the necessity for levee protection, and are most urgent in demanding it at almost any cost. Statistics have been compiled, and are frequently published, which show the cost of the Louisiana levee system to have been over thirty millions of dollars since 1865. No doubt it has been much more if all the unrecorded expenses incurred for levee work by parishes, corporations and individuals were included. But to continue piling up all these statistics of cost, and comparing the total with the money value of the system as it stands, would be like taking the cost of all the improvements, public and private, and expenses of administration in a great city from the time it was founded and contrasting the sum total of expenditures with the present assessed valuation. Of course, the city continually changes as it grows, like all other things that grow, and a part of the changes are destructive. It is the same with the levee system. Only, perhaps, in still greater degree. Levees are continually worn away by the winds and rains and degraded by the abuses of travel. But the great cause of their destruction is the caving of the river banks themselves. Until the banks of the rivers can be revetted and fixed in position, there can be no really permanent levee locations. As the erosion of the banks progresses steadily year after year in most of the concave bends, it must finally reach and destroy the levee lines, however far away they are originally located.

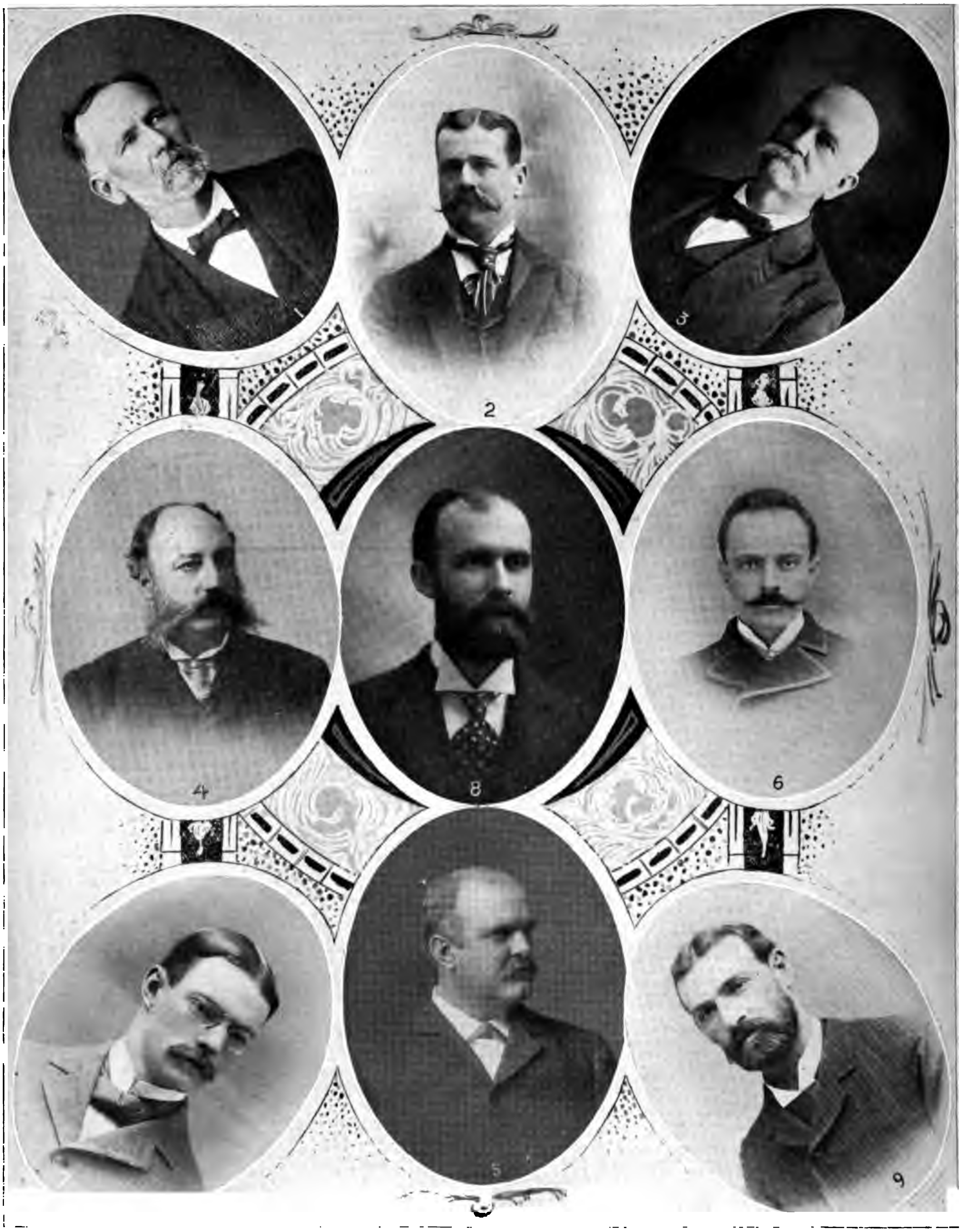
Caving river banks have been the principal causes of the destruction and abandonment of the older levees and of the continued great cost of maintaining and improving the levee system, not only in Louisiana, but throughout the alluvial valley. The revetment of the river banks in any general way would be a work of enormous extent and cost. In the present state of the art, it is far beyond the means of most of the levee districts. Until it can be undertaken with such resources as can only be supplied by the general government, it is not likely that the river banks will be revetted, except in extraordinary cases, where the interests involved are very large and important.

Just what grades and dimensions will be found requisite for the levees of the future can, as yet,



BOARD OF COMMISSIONERS, ATCHAFALAYA BASIN LEVEE DISTRICT
(ORIGINAL AND PRESENT MEMBERS)

6. (Center) T. G. SPARKS, President.
1. O. O. PROVOSTY, Attorney.
2. RICHARD McCALL, Ex-Member.
3. J. M. HOWELL, Deceased.
4. HONORE DUGAS, Assumption.
5. A. H. GAY, Iberville.
7. N. S. WILLIAMS, Deceased.
8. A. D. BARROW, Secretary.
9. ARSENE PERRILLIAT, Engineer.
10. JOS. TORRAS, Pointe Coupee.
11. HORACE WILKINSON, Ex-Member.
12. THOS. BEARY, Lafourche.
13. J. A. PREVOST, St. Marys.
14. V. M. LEFEBVRE, W. Baton Rouge.



BOARD OF COMMISSIONERS, PONTCHARTRAIN BASIN LEVEE DISTRICT

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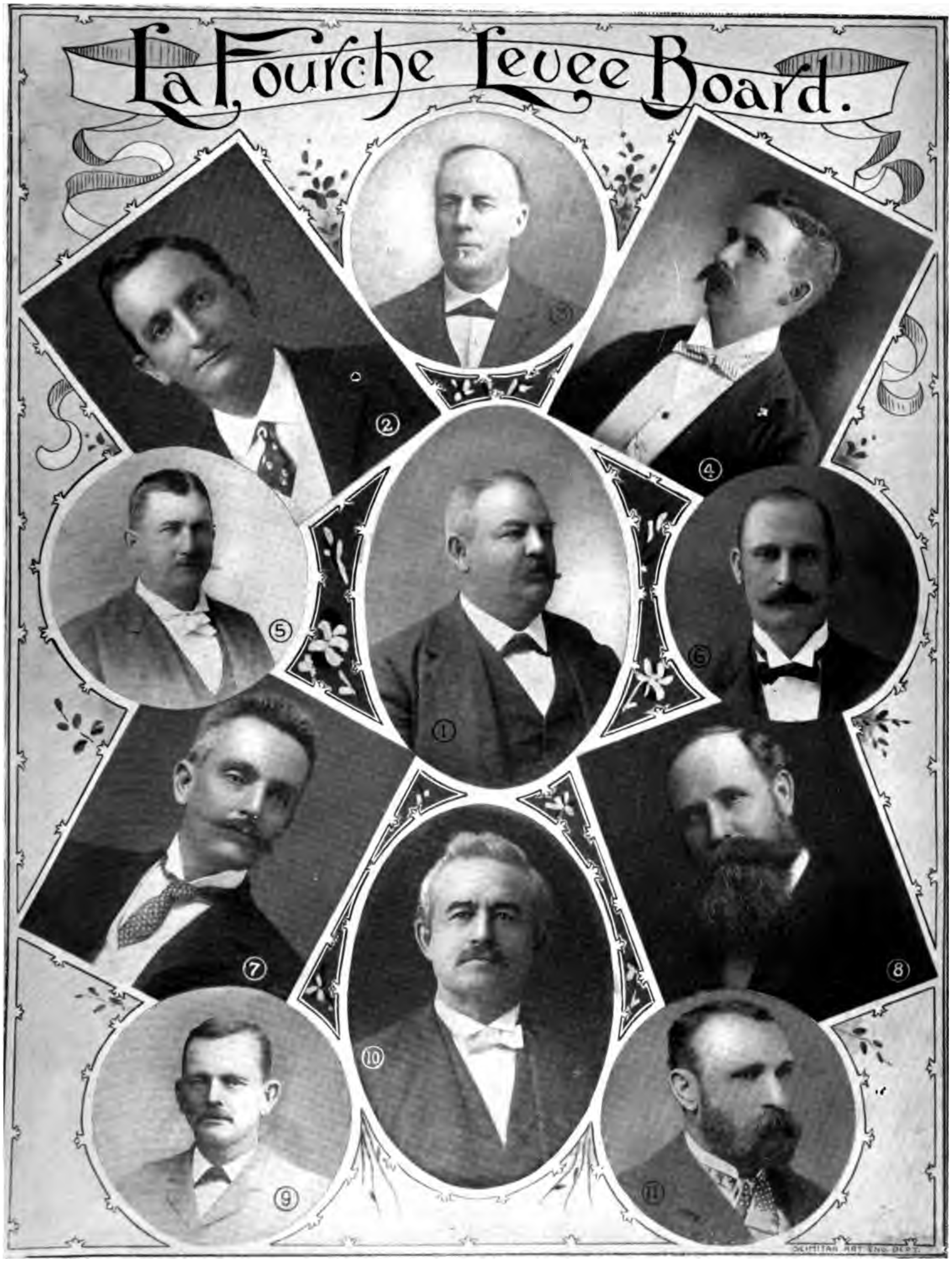
2. SIMON LE BLANC, Iberville Parish.
3. EMILE BOURGEOIS, St. James Parish.
4. LUCIEN SONIAT, Jefferson Parish.
5. P. M. LAMBREMONT, Secretary.
6. S. J. GIANELLONI, East Baton Rouge Parish.
7. W. P. MILES, Ascension Parish.
8. HUNTER C. LEAKE, President.
9. L. MONTEGUT, JR., St. John Parish.



. VICTOR MAURIN, President, Ascension Parish. 2. W. J. McCUNE, Secretary. 3. A. J. LALLANDE, Assumption Parish. 4 JOHN MARKS, Attorney.
5 R. PEREZ, Plaquemine Parish. 6 PAUL BERTHELOT, St. John the Baptiste Parish. 7 J. D. WILLIS, Railroads.
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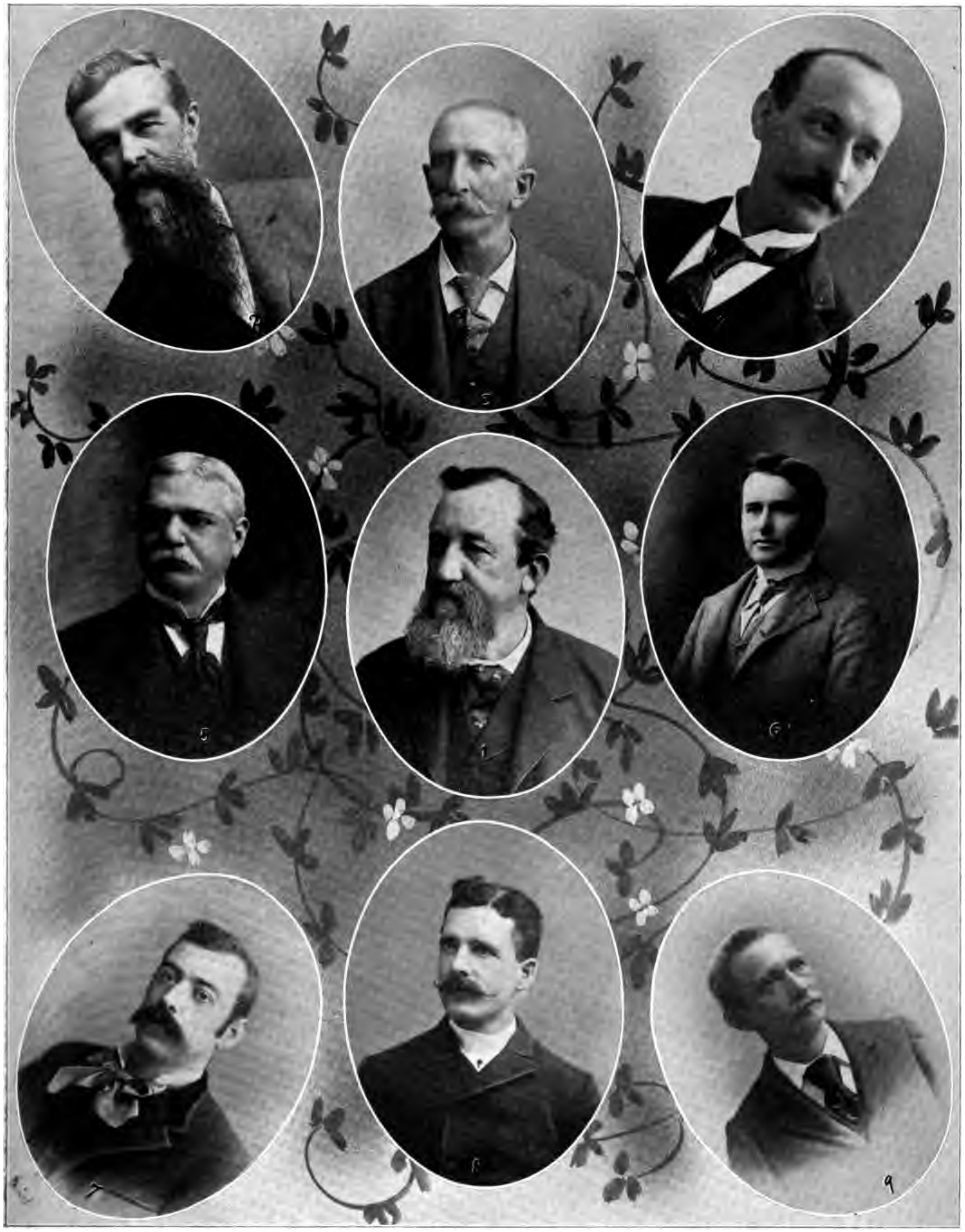
hardly be predicted. We must await the results of experience. It appears probable, however, that in the lower part of the state, levees on the Mississippi river—that is, those recently built or enlarged, and those now under construction—will not need to be made much higher for any floods that, judging from past experience, are likely to occur. In the upper part of the state it is equally probable that the increased heights of three or four feet will be found necessary.

Nor can it be foreseen to what extent the future public demand for increased width and strength, or for additional margin of safety in height, will require enlargment of cross-sections, with consequent additional earthwork.

There can be no doubt, however, that the work of levee improvement will go on in the future with even more vigor than it has shown in the past. There is also good reason to expect that the work of the future may be done with greater expedition and at less cost than heretofore. Much attention in now being given to earth-handling machinery, and a good deal of experimental work of this kind is now in progress or in contemplation upon the levees. The mule and the scraper seem likely, in their turn, to be largely superseded by steam dredges and other power excavators and conveyors. The use of such machinery will probably cheapen prices, for it should make the execution of earthwork independent of fluctuations in the markets for provisions, mules and feedstuffs, and of strikes of unskilled labor, and allow it to go on night and day at all seasons of the year.

It is the hope and desire of nearly every inhabitant of the alluvial valley that the federal government will take charge of the entire levee system of the Mississippi river. By its appropriations for this purpose during the past eighteen years, it surely stands morally committed to continue the improvements.

Probably the riparian states may never be relieved from some share in the cost and care of their levee systems, but whenever the United States takes upon itself the maintenance of levees on the Mississippi river as a national work, we in Louisiana—with the rest of the valley—may feel that the unequal war of the past five or six generations for the control of the river is at an end, and that security and prosperity have come to stay.



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6. GERVAIS LOMBARD, Engineer. 7. A. DUMSER. 8. T. J. MOULIN. 9. J. L. ADAM. All of New Orleans.

BOARD OF COMMISSIONERS OF ORLEANS LEVEE DISTRICT

THE HOMOCHITTO LEVEE DISTRICT

The Homochitto Levee District was created by resolution of the Mississippi River Commission, November 19th, 1894; its limits were defined to be the left bank of the Mississippi River extending from the mouth of the Yazoo River at Vicksburg to Baton Rouge. This district is, therefore, by far the longest on the Mississippi River, and while it is the longest it is also the narrowest, reaching at no point more than a few miles from the river, as from Vicksburg southward, on the east bank, the hills hug the river very closely. There are no great basins like that of the Yazoo-Mississippi delta, St. Francis basin, Tensas basin, and others. The following estimates, according to a survey made by Col. Geo. McC. Derby, Corps of Engineers, U. S. A., in 1895, show the cost of protection to this district and amount and value of lands to be protected:

LOCATION OF BASIN	Number of acres which would be protected	Value of same	Cost of Levee
Warrenton to Grand Gulf (Big Black sub-dis.)	15,500	$121,000	$214,000
Rodney to Coles Creek	16,926	127,000	44,000
Natchez to Ellis Cliff	16,537	89,000	25,000
Ellis Cliff to Fort Adams	23,375	206,500	413,000
Fort Adams to Tunica	17,861	134,000	59,000
Tunica to Bayou Sara	32,000	117,500	254,000

Since the great rise of 1897, which has caused the elevating of all levees along the rise to meet an increased flood level of 3 feet at Natchez and 3.8 at Vicksburg over flood water of 1882, these estimates must, no doubt, be materially increased. Regarding the character of the basins and their relative conditions looking to applications of an allotment, which the Mississippi River Commission had made, Col. Derby reports and reasons as follows:

"In all of these basins the land lies so low that if the basin is left open at its lower end substantially the whole basin will be flooded by back water; extensive back levees will therefore be necessary in all cases except in the basin from Natchez to Ellis Cliff and Fort Adams to Tunica, which being convex toward the river can be closed completely by front levees only.

Suitable syphons or culverts will have to be used to carry off the sipage and surface drainage which will accumulate in the lakes and swamps during high water."

"The cost of syphons and back levees is included in the estimates above because, while it is probable that if the United States were to build the front levees in these basins, the owners of the land might build the back levees, there is no guarantee of this; and where the cost of the back levee is nearly as great as the value of the land protected, it is by no means certain that the property owners would be willing to make the outlay.

In forming an opinion as to the wisest application of the available funds for this district, I have considered the following elements of the problem:

1st. Other things being equal, the funds should be applied where they will secure protection for the greatest possible amount of valuable property.

2nd. Preference should be given to localities where the banks are permanent, where the relief furnished would therefore be enduring and not merely temporary.

3rd. The rate at which funds will probably become available is important, because little or no benefit will be derived from any partial completion of the work in each basin. If the annual allotment for the district should continue to be $30,000, it would take many years of work to produce any useful effect in some of the basins; and if work were begun in any of these larger basins at present and Congress should cease to appropriate funds for levee building, the work done would practically go for naught.

4th. The disposition of the property owners to help themselves is an important consideration. Other things being equal, the funds should be applied where local interests are willing to contribute the most toward their own protection, both as a matter of justice and as a matter of policy.

5th. I have given no weight to the claim that there is any special obligation resting upon the Government to protect these small basins on account of damage alleged to have been caused them by construction of levees on the opposite side of the river, because after a somewhat thorough study of this claim in connection with suits now pending in the Court of Claims which were referred to me for report, I am of the opinion that there is no evidence of any such damage having been done, no detrimental change having taken place as yet in the flood height of the river between Vicksburg and Red River.

Reviewing the data given in the table above it will be seen that all considerations combine to narrow the choice at once to the basins from Natchez to Ellis Cliff, from Rodney to Coles Creek, and from Fort Adams to Tunica.

There would further be no difficulty in deciding in favor of the basin from Natchez to Ellis Cliff were it not for the fact that this is the one basin in which the property owners have done nothing toward protecting themselves. What weight should be given to this consideration is largely a question of policy with regard to which I do not know the attitude of the Commission; individually I should be disposed to give it considerable weight."

As shown by the report quoted, some parts of this district would require both front and back levees, as streams flow from the hills to the river, owing to the fact that these are but small basins, and allow only the accumulated waters of small streams. It must not be understood that the phenomenon of the Mississippi River is different to what it is in other districts, but the basins are very small, and consequently each basin must have its outlet to the river. Therefore this outlet serves the same purpose, in miniature, that the St. Francis River or the Yazoo River do to the basins of which they are the extreme boundary. The land owners and inhabitants of the most favored basins mentioned above have vigorously contended for annual allotments to levee them. The basin from Natchez to Ellis Cliff seems likely to secure the first allotment on the grounds of most favored conditions, unless they should decide in line of the suggestion of Col. Derby to allot to such of the three favored basins as shows the largest spirit of co-operation. In that case there would be an interesting bit of rivalry between these three basins.

The protection of these basins must, of course, be dependent on many contingencies. Should the Congress adopt the suggestion embodied in the report of the Senate Committee on Commerce for a total appropriation of eighteen or twenty millions of dollars to complete the levee system, these basins would no doubt receive substantial allotments and finally secure complete protection. Should, however, the appropriations be limited and should in the next few years unlooked for disasters occur to the existing levees the application of funds to these basins, or at least to all save those above mentioned, would be delayed. With proper protection the value of these lands could be increased many times.

THE MISSISSIPPI RIVER—ITS GREAT VALLEY—ITS RICH ALLUVIAL BASIN

As this is simply a description and not a history, I will attempt no reference to the settlement of the Mississippi Valley and its early fascinating history.

The drainage area of the Mississippi River is the most remarkable and most extended of any on the globe. While the Amazon River has a larger size and discharge, yet it has nothing like the number of miles of navigable tributaries, nor the number of square miles of basin. The Mississippi River not only takes to the Gulf of Mexico water from the wood-clad summits of the Appalachians, but it carries equally that which falls on the part of the barren cliffs of the Rockies. It extends in the northeast almost to the shores of Lake Ontario in New York, where steamboats have been known to ascend as far as Olean in that State, and in the northwest it reaches beyond the confines of the United States and drains tens of thousands of square miles of Canadian soil. These hundreds of millions of acres of surface pour their surplus water down as a vexing problem for the people who live behind the levees to solve. Over one and a quarter millions of square miles is included in this surface—more than forty-one per cent of the entire area of the United States proper—and in these forty-one per cent lie the granaries of the world and the work-shop of the universe. Nowhere on the face of the globe is there such an area of such unsurpassing fertility, and the world has never seen such a remarkable industrial development as has sprung up in this great basin bounded by the coal fields and the wonderful iron cities of the eastern ranges on one hand, and by the mountains of gold and silver of the west on the other.

These two metals which command the commercial and industrial supremacy of the world, are like sentinels standing on the two rims of this great basin encouraging the busy bee-hives to a keener activity to increase its wonderful agricultural productions which feed the hungry millions of the older countries of the Occident, and to still further push the wonderful success in mechanical and manufacturing activity to still further conquer the markets of the world. A closer observation and an analysis of this wonderful basin reveals the greatest wheat and corn fields the world has ever known—tilled, garnered and shipped in a manner so skillful with labor-saving inventions and methods so remarkable that it becomes the marvel of the age.

Then the manufacturing and mechanical activity—the wonderful progress in invention, science, chemistry, together with unexcelled natural conditions, have conspired to enable this country to drive its opponents almost from the trade of the universe. And these two sentinels on the rim which confirm, strengthen and extend America's supremacy see even more than this! They see the great cotton-producing section of the universe which furnishes the feed of the loom which clothes the world not only in raiments of acknowledged cotton products, but that it rivals the sheep for manufactures of wools, the cocoon for the manufacture of silks, and the oil from its seed claims sistership with the luscious olive.

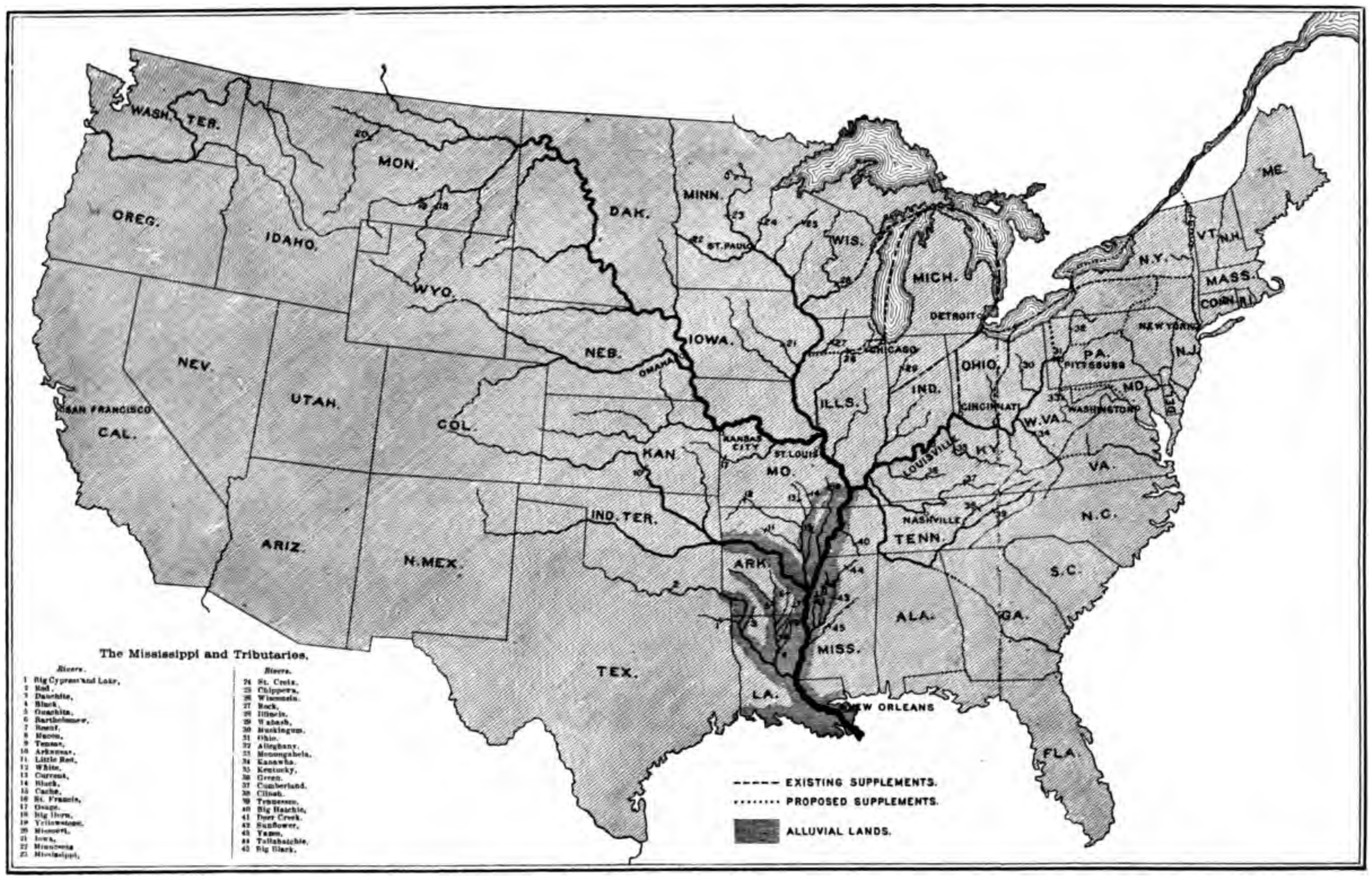
This same cotton seed, which before the war was so despised as to call forth edicts from States for their destruction to prevent contamination of waters and in the interest of the promotion of the public health, is now aiding king cotton to hold his throne.

The value of the products of the seed of a ten-million-bale crop in its crude condition—twenty-five dollars to a ton—is one hundred and twenty-five millions of dollars!

The possibilities of industrial force in the cotton lint, stalk and seed is illimitable and calls forth a speculation as to what its use will be to future generations!

In this basin is springing into existence wonderful capacity for productions of both rice and sugar. The cultivation of the first is not confined to the area of lowlands where it was considered only possible to cultivate it, and the latter not limited to the sugar cane for its making nor confined to the nearly tropical south as we once thought necessary.

Oh, there is a wonderful possibility yet unknown which the touchstone of an intelligent extension of



THE MISSISSIPPI RIVER AND THE WONDERFUL SCOPE OF ITS TRIBUTARY SYSTEM OF WATERWAYS the modern improvements and discoveries in agriculture will develop.

Then why should not this wonderful basin be able to pour its extraordinary cornucopia of productions to the great world through the most perfect system of water channels known to sciences? The growth of this basin in manufactures, wealth and population since 1880 are shown on the reverse of the map which follows page 216, and presents a picture of wonderful activity and success in all lines of agriculture, mining and in all forms of industrial art.

The total number of miles of navigable streams which the Mississippi and its tributaries form is over sixteen thousand and a liberal and rational improvement of internal waterways and the completion of projected canals will make this much larger. In fact when the deep water canals which will connect it with the Great Lakes are finished and become a part of its system, we will claim these Great Lakes and their tributaries as a part of the Mississippi River Valley. It now has a connection with these Great Lakes by means of small canals at different points, but the proposition which now claims the attention of the people of the Middle West is the connecting of the Great Lakes and this great river through the Chicago, Desplaines and Illinois Rivers.

The Chicago Drainage Canal now empties the waters of Lake Michigan by these channels through the Mississippi into the Gulf of Mexico. The deepening of this canal and these rivers will afford a solution of one of the greatest projects of modern times. With the completion of the Nicaragua Canal and the deepening of the channels mentioned, the general improvement of the Mississippi River, and by the use of steel barges, it will be possible to ship grain and other burdens of commerce from these Lakes, down the Mississippi River, through the Nicaragua Canal and land them in unbroken cargoes at Manila, Hong Kong and Yokohama.

These barges of perfect sea-going qualities are now in use on the Great Lakes and the recently successful trip of similar crafts from St. Louis to New Orleans, of which illustrations will be found on page 290, demonstrates the correctness of these conclusions and the possibility of this prediction being realized in the not distant future.

The contemplation of the second century of commerce through this river opened up avenues of speculation of almost stupendous width and romantic insight. Just as the "laughable propositions" of Mulberry Sellers have been discounted by the actual accomplishments of science, mechanical devices and colossal business ventures, so will the chimera known as the "Mississippi bubble" be discounted by actual accomplishments in this rapidly advancing era of commercial growth and development.

With the further advance of the Mississippi Valley (I speak of it in its wider significance) in commerce, manufactures, agriculture, mining, etc., this great stream will become more and more important, and should be made more and more perfect as a channel by which all these productions may be transported cheaply to fill the growing demands from South American countries, and from the Orient, as well as to the extension of our great trade with Europe.

An admirable article in preceding pages, contributed by Gen. Leon Jastremski, formerly United States Consul at Callao, Peru, has shown some of the possibilities of this trade to a part of the South American countries. When we consider the entire South and Central America, the islands of the Pacific, and the Orient with its teeming millions, we can multiply these deductions many times over. But it is useless for me to try to add to the statements made by Hon. M. J. Sanders, Mr. Stuyvesant Fish, Capt. John W. Bryant, Elmer E. Corthell, Hon. Charles Scott, Maj. James B. Quin, and others whose articles adorn the pages of this book.

An intelligent and comprehensive plan of improvement of the internal waterways of the United States is something which is demanded by the farmer, the merchant, the manufacturer, and even the vast railroad systems, which find water competition not only healthful, but improving to their traffic, and adding to the net earnings of their roads.

THE NAVIGABLE STREAMS AND THEIR VALUE

There are in the United States, according to Poor's Manual for 1899, 184,894 miles of railroads. These cost $10,256,275,586.

The expense of maintenance and improvement runs into the hundreds of millions of dollars annually.

Now the 16,000 miles of waterways forming the Mississippi River system should be valued at not less than $900,000,000, and its improvement should be rated accordingly.

THE ALLUVIAL VALLEY OF THE MISSISSIPPI RIVER

Linked with the improvement of the River, becomes a problem of stupendous importance to the people of the entire United States. It is the protection of the alluvial basins through which this river runs. It is unnecessary for me to discuss the equity of this matter, for this has been so ably done in the article by Judge Blanchard of the Supreme Court of Louisiana, formerly Senator from Louisiana and prior to that a member of the National House of Representatives, and for two terms chairman of the Committee on Rivers and Harbors of that body. If the Mississippi River be national in extent, in government ownership, and in benefits, it should also be national in the matter of control.

The measurements of the Mississippi River Commission put the overflow section of the Mississippi River at 29,790 square miles, or a total acreage of 19,065,600. The estimate of the alluvial lands along the Lower Mississippi and tributaries has been put by writers at 41,193 square miles, or 26,363,520 acres, but in this discussion I wish to assume to treat it from the standpoint of the measurements of the Mississippi River Commission, but remarking en passant, that the highlands in the various basins of alluvial formation, but above overflow now, which are exempt from the calculations of the Mississippi River Commission, are almost equally interested in a system of protection which would allow the safe development of the overflow sections, since they are now hampered by lack of rail communication, the extension which necessarily depends on safety from the ravages of periodical overflows. In elaboration of this view see article of Judge Taylor of the Mississippi River Commission on page ......

As an eloquent and truthful presentation of the whole commercial aspect of this question, and a conservative computation of its present commercial importance, and future commercial possibility, I could not do better than submit an open letter which the Hon. Charles Scott, President of the Interstate Mississippi River Improvement and Levee Association, has addressed to the people of the United States, in behalf of those who live behind the Mississippi River levees. This letter has been, and is still being, widely circulated, and has created marked attention and much comment, the latter being in the nature of wonder and surprise that the government of the United States has permitted a subject of such great commercial importance to suffer from lack of the paltry millions which would make possible this wonderful development.

The subjoined statement shows the population for 1880, 1890 and 1900 of the alluvial counties and parishes of the Mississippi River, including those of the Red, Arkansas, White and St. Francis River basins. There are others which have more or less alluvial land within their borders, but those mentioned below are the principal alluvial counties and parishes.

SUMMARY

County	Population 1880	Population 1890	Population 1900
STATE OF ILLINOIS			
Alexander	14,808	16,563	19,384
STATE OF TENNESSEE			
Lake	3,968	5,304	7,368
Lauderdale	14,918	18,756	21,971
Obion	22,912	27,273	28,286
Shelby	78,430	112,740	153,557
Tipton	21,033	24,271	29,273
Dyer	15,118	19,878	23,776
STATE OF MISSOURI			
Cape Girardeau	20,998	22,060	24,315
Dunklin	9,604	15,085	21,706
Mississippi	9,270	10,134	11,837
New Madrid	7,694	9,317	11,280
Pemiscott	4,299	5,975	12,115
Scott	8,587	11,228	13,092
Butler	6,011	10,164	16,769
Stoddard	13.431	17,327	24,669

STATE OF ARKANSAS

County	Population 1880	Population 1890	Population 1900
Chicot	10,117	12,419	14,528
Clay	7,213	12,200	15,886
Craighead	7,037	12,025	19,505
Crittenden	9,415	13,940	14,529
Desha	8,973	10.324	11,511
Greene	7,480	12,908	16,979
Lee	13,288	18,886	19,409
Mississippi	7,332	11,635	16,384
Poinsett	2,192	4,272	7,025
Pulaski	32,616	47,329	63,179
Jefferson	22,386	40,881	40,972
Phillips	21,262	25,341	26,561
St. Francis	8,389	13,543	17,157

STATE OF MISSISSIPPI

Bolivar	18,652	29,080	35,427
Coahoma	13,568	18,342	26,293
De Soto	22,924	24,183	24,751
Holmes	27,164	30,970	36,828
Issaquena	10,004	12,318	10,400
LeFlore	10,246	16,869	23,834
Quitman	1,407	3,286	5,435
Sharkey	6,306	8,382	12,178
Sunflower	4,661	9,384	16,084
Tallahatchie	10,926	14,361	19,600
Tunica	8,461	12,158	16,479
Warren	31,238	33,164	40,912
Washington	25,367	40.414	49,216

STATE OF LOUISIANA

Ascension	16,895	19,545	24,142
Assumption	17,010	19,629	21,620
Avoyelles	16,747	25,112	29,701
Bossier	16,042	20,330	24,153
Caddo	26,296	31,555	44,499
Caldwell	5,767	5,814	6,917
Catahoula	10,277	12,002	16,351
Concordia	14,914	14,871	13,559
East Baton Rouge	19,966	25,922	31,153
East Carroll	12,134	12,362	11,373
Franklin	6,495	6,900	8,890
Iberia	16,676	20,997	29,015
Iberville	17,544	21,848	27,006
Jefferson	12,166	13,221	15,321
Lafourche	19,113	12,095	28,882
Madison	13 906	14,135	12,322
Morehouse	14,206	16.780	16,634
Natchitoches	19,707	25,836	33,216
Ouachita	14,685	17,985	20,947
Plaquemine	11,575	12,541	13,039
Pointe Coupee	17,785	19,613	25,777
Rapides	23,563	27,642	39,578
Red River	8,573	11,318	11,548
Richland	8,440	10,230	11,116
St. Bernard	4,405	4,326	5,031
St. Charles	7,161	7,737	9,072
St. John-the-Baptist	9,686	11,359	12,330
St. Martin	12,663	14,884	18,940
St. Mary	19,891	22,416	34,145
St. James	14,714	15,715	20,197
Tensas	17,815	16,647	19,070
Terrebone	17,957	20,167	24,464
West Baton Rouge	7,667	8,363	10,285
West Carroll	2,776	......	3,685

The above summary will show that these counties and parishes are rapidly increasing in population; their wealth has increased even more rapidly. Improved levee conditions are responsible for most of this increase, and with the levees completed to the line of absolute security, giving confidence to capital and an impetus to railroad building and general development in agriculture and timber manufacturers, these sections would develop with amazing rapidity during the next decade.

A discussion of the growth in population and deduction which naturally grow out of a summary and comparison like the above, will be reserved for the description of the alluvial lands of the various states.

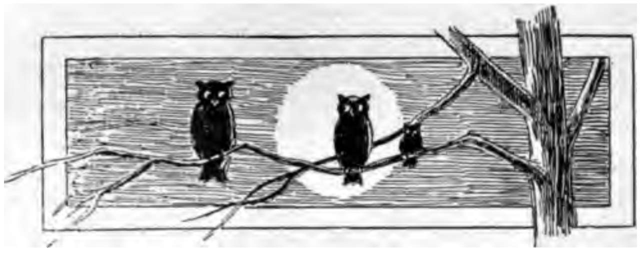
It is impossible that, with the reaching out after new fields for the employment of capital and establishment of happy homes that these extensive basins, unexcelled in fertility on the face of the Globe, should remain undeveloped.

As aptly expressed by Mr. Scott in his letter: "The trade which should be developed from the fertile millions of acres now covered with virgin forest, as they are brought under the plow, may be greatly needed in the near future to foster and continue industrial activity in the United States."

Our country with even its vast resources and its ever-widening foreign trade cannot remain commercially prosperous and industrially progressive without increasing development at home, and certainly there is no greater field, none affording finer opportunity for the employment of surplus labor, than the bringing into commercial activity of these millions of acres of land, with an annual trade capacity of two hundred millions of dollars, to the consummation of which the national government should devote its energies.

To show the wonderful possibilities of development presented, we might take as a comparison in the little kingdom of Belgium, which, with a total of very little more than one-half of the area of the undeveloped lands of these various alluvial basins of the Mississippi River, has a population of 6,750,000 souls. With the same density of population there would be on lands which are now absolutely in their virgin condition a total of 12,000,000 inhabitants; or of the density of Holland there would be 9,000,000 inhabitants, and the alluvial lands of the Mississippi River are incomparably more fertile than those of either of these little kingdoms. As shown by Mr. Scott's letter, the bringing into cultivation of the 13,000,000 acres which now lie in their primeval condition would cause not less than two hundred million dollars' worth of trade per annum. When it is generally known that these lands will be protected by the general government and that the dangers of overflow are over, the rush of people and capital into these basins will discount the wild rushes to Oklahoma and other abandoned Indian Reservations when thrown open for settlement.

And the resultant trade will be a dynamic force to keep the wheels of commerce and manufacture in motion, and to hold and increase the present activity in all branches of industry.



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Interstate
Mississippi River Improvement
AND
Levee Association.

To Business Men of the United States Having Trade Relation with the Alluvial Sections of the Mississippi, Greeting:

The alluvial valley of the Mississippi is the richest and largest on the globe. It comprises six great basins, of the following designation and area:

ST. FRANCIS	6,706
YAZOO	6,648
WHITE RIVER	956
TENSAS	5,370
ATCHAFALAYA	8,109
PONTCHARTRAIN	2,001
Total Square Miles	29,790

It rests in the States as follows:

ILLINOIS	65
MISSOURI	2,874
KENTUCKY	125
TENNESSEE	453
ARKANSAS	4,625
MISSISSIPPI	6,926
LOUISIANA	14,695
Total Square Miles	29,790

This splendid area contains 19,065,600 acres, of which probably 18,000,000 acres are susceptible of the highest degree of cultivation, but it is estimated that up to this time less than 5,000,000 of acres have been utilized for agricultural purposes. The total value of the staple crops raised on these lands heretofore brought under the plow, will approximate seventy-five millions of dollars per annum.

What a wonderful empire of richness lies here yet undeveloped!!

In the face of disastrous overflows, and the dangers and uncertainties of high waters, this alluvial country is steadily advancing in its productive capacity and in its importance as a market for manufactured goods and agricultural products.

Since 1890 its cotton production has increased fully 40 per cent. The Louisiana sugar crop from 1884 to 1889 averaged 140,000 tons per annum; from 1890 to 1895, it averaged 265,000 tons per annum.

The people of this valley are the largest buyers in the world in proportion to their means, even purchasing most of their meat and meal, while they do not produce, it is estimated, over one-half of the provender for their mules and other stock.

The great mauufacturers of shoes, cotton and woolen goods, farm machinery, furniture, drugs, liquors, and hundreds of other articles, find in this valley their best customers, while the raisers of wheat, corn, hay, mules, hogs and cattle, always find here a steady and growing market.

With millions more of these fertile areas quickened into life, and smiling with generous harvests as the direct result of adequate protection from the floods, will come double, or either quadruple, demands for the output of the industries and farms of all parts of our common country.

That such protection is entirely practicable is no longer a debatable question. The holding of our entire levee front in the sugar district of Louisiana in 1897, and of the whole line in many of the upper districts in the face of the great flood of that year; and since then, the safe conduct to the sea of the high waters of 1898 and 1899, without a single disaster, will convince every impartial mind of the efficacy of an adequate levee system, and that our safety in the future is simply a matter of money and engineering skill.

We ask you, then, to help us get these; and we, in turn, will diffuse our increased trade throughout the length and breadth of the country, thus adding to your prosperity as well as ours.

The trade which should be developed from the fertile millions of acres now covered with virgin forest, as they are brought under the plow, may be greatly needed in the near future *to foster and continue industrial activity in the United States.*

A word now as to the cost of these improvements, looking to the reclamation and protection of this vast fertile empire: The Committee on Commerce of the United States Senate recently gave this important subject an exhaustive and intelligent examination, and their report indicates that it would require but eighteen or twenty millions of dollars to complete and perfect the entire levee system of the Mississippi River. This is not more than one-fourth of the present annual production of staple products in the section to be protected, and is not equal to more than one-tenth of what could be produced on its thirteen or more millions of acres of land (as fine as any on the globe) which are not now in cultivation.

If by the spending of this sum, small when compared with the results to be obtained, we can bring about this wonderful development, which would distribute annually an additional trade equal in value to two hundred millions of dollars, what a wonderful return for the money!! As an economic move it would be the best investment ever made by our government, or ever championed by those who seek enlarged markets for the output of our factories, and of our Northern and Western farms.

But aside from the business and financial aspect of the question, there is involved in it an element of justice to the people of the valley; for it must be remembered that the rainfall from the Apalachees to the Rockies, flowing down through nearly 16,000 miles of navigable, utilized waterways, is a constant menace to those who dwell behind the Mississippi River levees. We appeal then with confidence to the whole commercial interests of the United States, and to the great grange interests of the country, whose prosperity is so closely interwoven with that of the dwellers of the valley, to use their influence with congress to get for us immediate protection, that we may quicken into life an unparalleled development, as we turn our riparian forests into fertile fields. Give us your active support that we may produce on these millions of acres of virgin soil rich and abundant crops of cotton, rice, sugar and tobacco.

The eloquent Garfield once remarked—"If there is one thing that is more national than another, it is the great Mississippi River."

Give us your influence and assistance, then, to control *the nation's river for the nation's good.* You can do this in an effective and practical way by writing urgent letters to your Representatives and Senators at Washington; not in a perfunctory way, but asking them as a personal favor and as a public duty to vote liberal appropriations for the protection of the Mississippi Valley. Do not stop here, but induce your commercial, industrial and financial bodies to adopt strong resolutions, memoralizing congress to take the matter up and solve it in the interest of national trade and prosperity. And, after all, both the country and the Congress should remember that this great public work, beyond the power of the riparian States, is only an act of justice to a people who have spent over thirty-eight millions of dollars in an effort to protect their homes from the overflow of this great national sewer, whose accumulated waters from twenty-six states and territories, embracing nearly one-half of the United States, and from a part of Canada, is a constant menace to their prosperity and an obstacle to their development.

With the intelligent and active co-operation of yourselves, and other influential men having trade relations with this alluvial basin, we cannot fail to obtain Congressional aid for the speedy completion of our levee system, and I venture to add that in helping us to this end, you are also helping yourselves and all parts of our common country.

I have the honor to remain, yours respectfully,

CHARLES SCOTT, President.

(Facsimile from original plate.)

THE DAILY PRESS OF THE MISSISSIPPI RIVER ALLUVIAL DISTRICT

But mightiest of the mighty means,
On which the arm of progress leans,
Man's noblest mission to advance,
His woes assuage, his weal enhance,
His rights enforce, his wrongs redress—
Mightiest of mighty is the press.
—*Sir John Browning.*

PAGE M. BAKER
Editor New Orleans Times-Democrat

THE LATE HENRY J. HEARSEY
Editor of New Orleans States

W. C. CHEVIS

Editor Baton Rouge (La.) Advocate

JAMES W. LAMBERT

Editor Natchez (Miss.) Democrat

MRS. JULIA SPARKS RULE

Editor Shreveport (La.) Elite

MRS. HALA HAMMOND BUTT

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Evening Scimitar

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Editor Donaldsonville, La., Chief

W. M. NEAL
Editor Helena (Ark.) World

E. E. ELLIS
Editor Cairo (Ill.) Telegram

RAILROADS

AND THE

ALLUVIAL LANDS OF THE MISSISSIPPI RIVER

Some of the Presidents and General Officers of the Railroads which are factors in the Development of the Alluvial Lands of the Mississippi River . . . .

INCLUDING SOME OF THE PIONEER ORGANIZERS

THE LATE JAY GOULD

THE LATE COLLIS P. HUNTINGTON

GEORGE J. GOULD

President Missouri Pacific System

STUYVESANT FISH

President Illinois Central and Y. & M. V. Railroads

M. E. INGALLS

President C., C., C. & St. Louis (Big Four) and Chesapeake & Ohio R. R's

EDWIN GOULD

President St. Louis S.-W. R'y (Cotton Belt)

THE LATE EDWARD S. WASHBURN

J. W. THOMAS
President Nashville, Chattanooga & St. Louis Railroad

B. L. WINCHELL
President Kansas City, Ft. Scott & Memphis Railway

C. G. WARNER
Vice-President Missouri Pacific Railway.

H. E. HUNTINGTON
Vice-President
Southern Pacific Railway

J. T. HARAHAN
Second Vice-President
Illinois Central and Yazoo & Mississippi Valley Railroads

JULIUS KRUTTSCHNITT
Fourth Vice-President and General Manager
Southern Pacific Railway

RUSSELL HARDING
Second Vice-President and General Manager
Missouri Pacific Railway

W. W. FINLEY

Second Vice-President Southern Railroad

F. H. BRITTON

Vice-Pres. & Gen. Mgr. St. Louis S.W. Railroad

S. W. FORDYCE

F. S. GANNON

General Manager Southern Railroad

L. S. THORNE

Third Vice-Pres. and Gen. Mgr. Texas & Pacific Railroad

W. A. TURK

General Passenger Agent Southern Railroad

H. C. TOWNSEND

General Passenger Agent Missouri Pacific Railroad

T. J. HUDSON

Traffic Manager Illinois Central and Y. & M. V. Railroads

A. H. HANSON

General Passenger Agent Illinois Central and Y. & M. V. Railroads

C. C. HARVEY

President O. & C. R'y

W. C. DOTTERER

Receiver and Gen'l Manager New Orleans & Western R. R. and Chalmette Terminals

J. E. LOCKWOOD

Gen'l Passenger Agt. Kansas City, Fort Scott & Memphis R. R.

M. GILLEAS

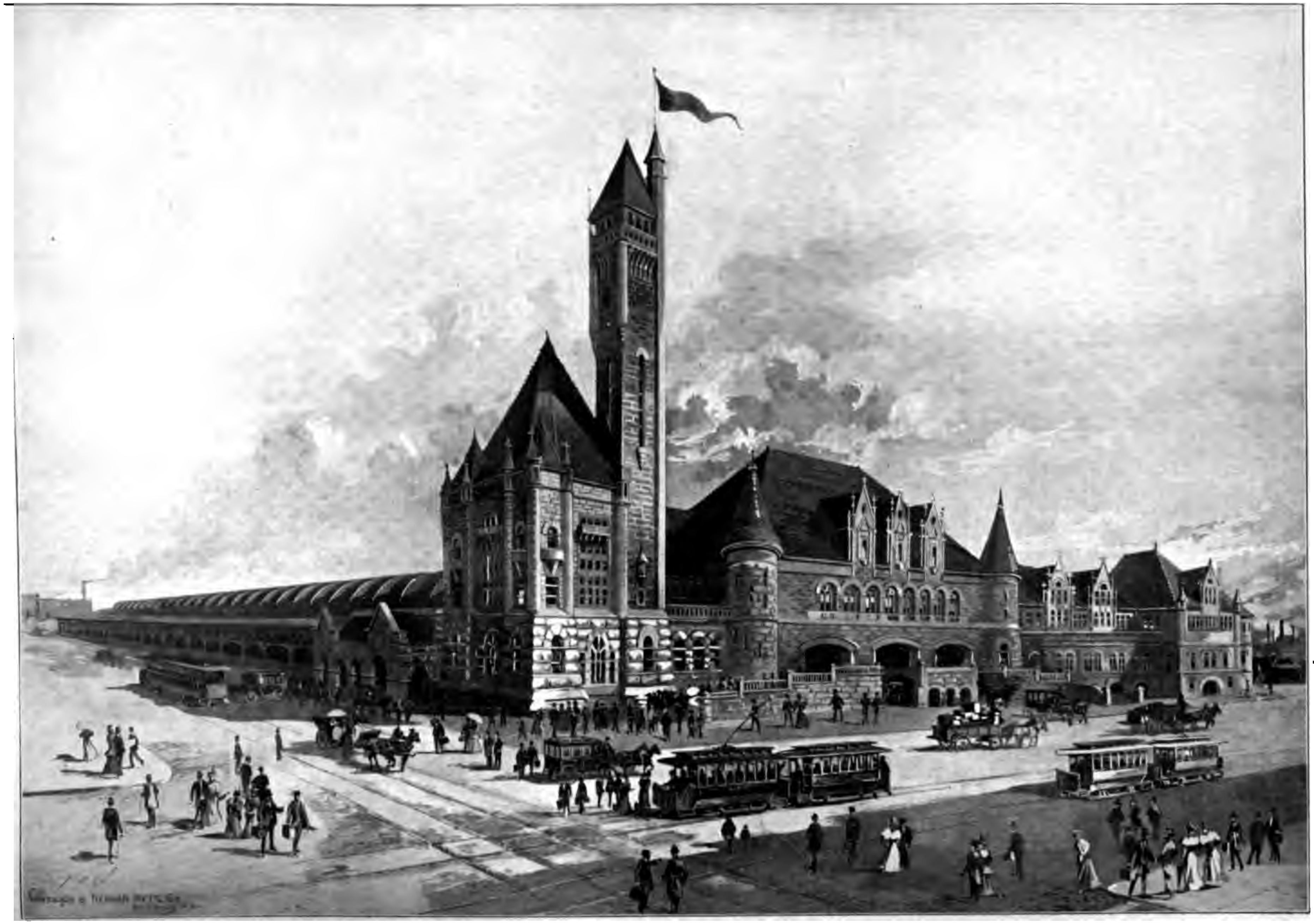
Ass't Gen'l Superintendent Illinois Central and Y. & M. V. Railroads

CHARLES HYDE
President New Orleans & N.-W. Railroad

LOUIS K. HYDE
General Manager New Orleans & N.-W. Railroad

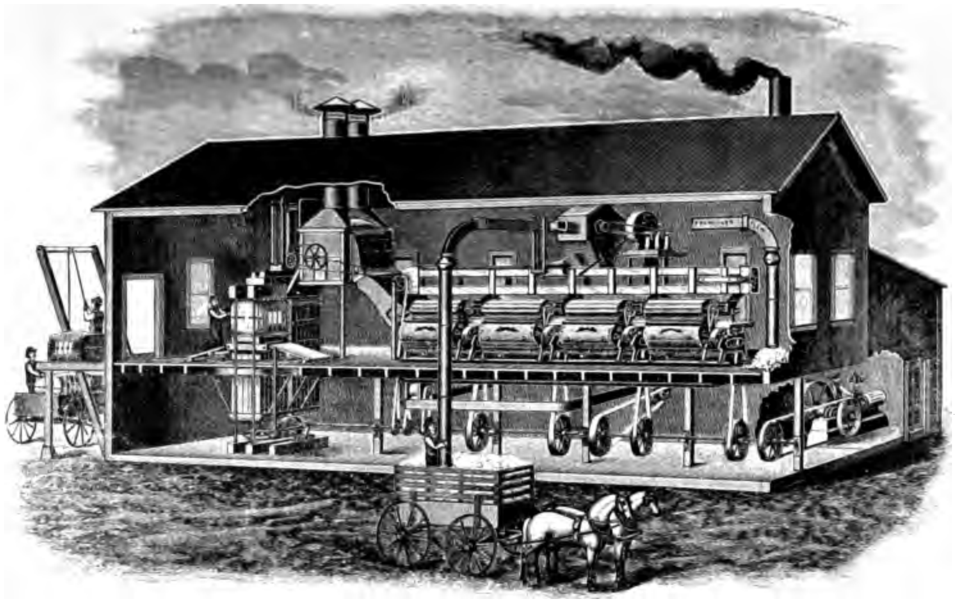
LOUIS B. HOUCK
General Manager "Houck Railroads"

E. M. FORD
General Manager Decketville, Osceola & Northern Railroad



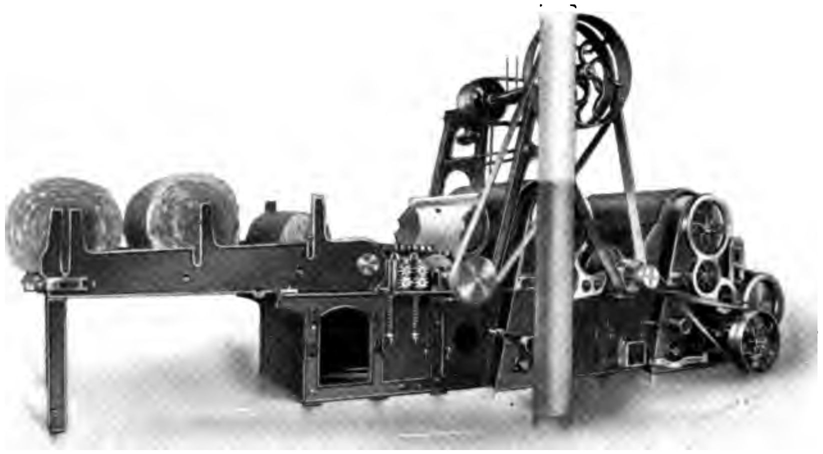
GRAND UNION DEPOT, ST. LOUIS, MO.

LINT ROOM OF AN OLD-STYLE COTTON GIN



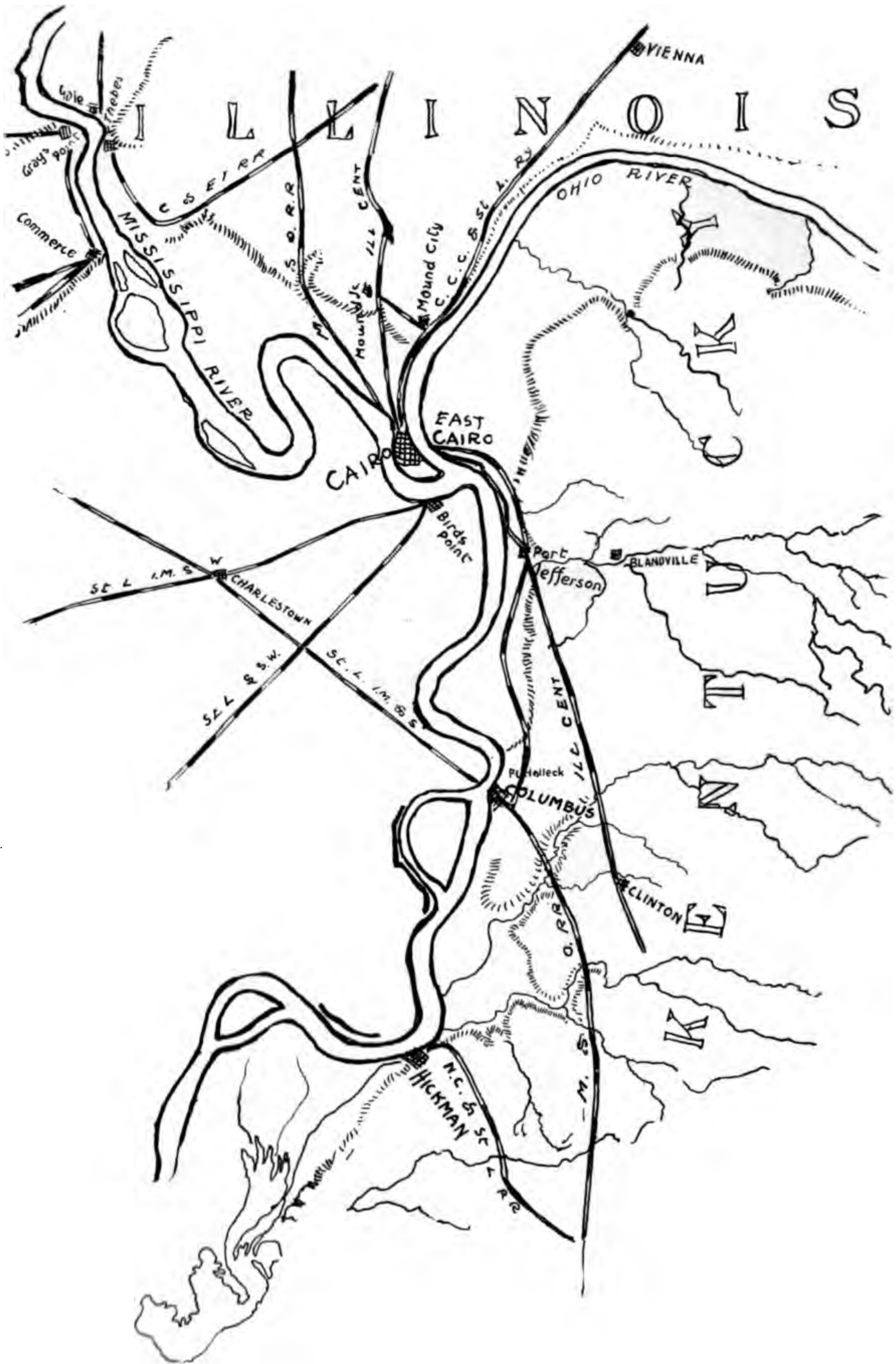
THE NEW MUNGER SYSTEM COTTON GIN

THE ROUND BALE SYSTEM



THE ROUND BALE SYSTEM

SHOWING THE IMPROVEMENT IN COTTON HANDLING



ALLUVIAL LANDS IN ILLINOIS AND KENTUCKY

CAIRO, ILLINOIS

BY J. R. RECTOR, POSTMASTER

Cairo, standing at the gateway of Modern Egypt, the Queen City of Southern Illinois, is a living, shining example of the benefits accruing from the very system of levees advocated in these pages.

The Cairo levees are the outgrowth of years of experience in the building of these bulwarks of safety. Away back, early in the Nineteenth Century, when the natural advantages of the point of land at the confluence of the two greatest rivers in North America first presented themselves to the early pioneers, it was keenly apparent that the prime requirement of all was some means of keeping the waters of these two rivers from encroaching on the homes and workships of those who might be induced to locate on the peninsula. That the pressing need of what we now call good levees was not apparent at so early a day, is evidenced by the fact that when an English company sought to obtain a foothold in this section of the country and establish iron works, mills, etc., on the present site of the city, they were content to surround them with narrow ridges of earth, crudely, not to say rudely, thrown together, and when the floods came the costly buildings and expensive machinery were swept away and ruin and desolation followed.

This disaster, which would have been foreseen had our English brethren realized the power of the mighty rivers, resulted in discouragement, and a long period of inaction resulted.

The building of the first railroad marked a new era in Cairo's history, and the inaction which followed the first disaster was succeeded by a spirit of push and enterprise, which has at last resulted in success.

Resting securely behind a system of massive levees more than seven miles in extent, every foot of which is now up to full fifty-eight feet above low-water mark, with bases, slopes and tops built after the most scientific methods under the personal supervision of skillful engineers, the inhabitants know they are secure from the highest floods since Noah's time.

Inside those splendid bulwarks the streets have been filled to a height approximating the levees themselves, thus lending additional security to the enterprising people who had so long warred with nature for supremacy. Most of those streets have been paved with a material known as Elco concrete—a species of broken stone mingled with iron ore found in inexhaustible quantities in Alexander County, only a few miles away—which is practically indestructible, and possesses the rare virtue of becoming harder and more compact the longer it stands.

Supplementary to this levee system, which is confessedly superior to the far-famed dykes of Holland, is a system of sewerage and pumps, by which the city is kept perfectly free from the accumulation of water inside the levees during protracted high stages in the rivers. The pumps alluded to are located on the Ohio River levee. They possess enormous lifting power and are capable of discharging many thousand cubic feet of water every minute. The sewer system conveys all the water which may accumulate from rainfall or natural sipage directly to the pumps, from all parts of the city, and it is discharged into the river. The result is that Cairo is not inconvenienced by prolonged periods of high water. Here not a wheel stops, not a factory suspends, not a mill ceases running because of the floods.

Now, what have been the results? Simply inestimable. The liberal, broad-gauge policy of the city in inaugurating the pumping system as an auxiliary to the levees has already borne good fruit, even though of comparatively recent origin. Old factories, realizing that they may now proceed on a more extensive scale without fear of inundation or even a temporary wetting, are branching out and building extensive additions to their works. New manufactories have been attracted here by the double inducement: proximity to an inexhaustible fuel and lumber supply, and perfect protection to their plants.

The advantages that Cairo may offer to prospective enterprises, or old business concerns seek-

JOHN A. MILLER
President Business Men's League

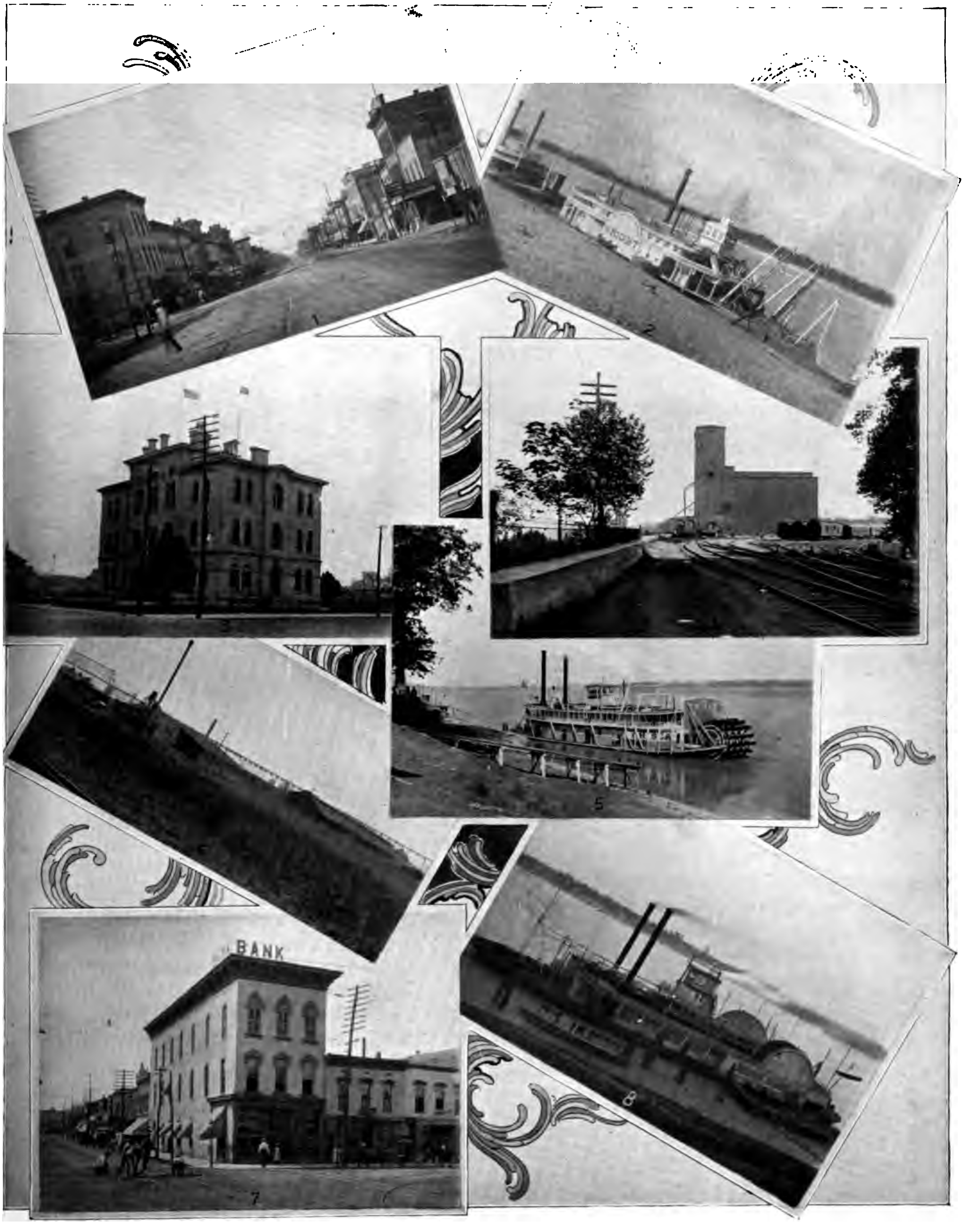
C. R. STUART
Secretary Business Men's League

E. A. SMITH
President Cairo Board of Trade

P. W. BARCLAY
Secretary Cairo Board of Trade

THE LATE THOS. W. SHIELDS

THE LATE W. P. HALLIDAY



VIEWS OF BUSINESS STREETS, RIVER, AND PART OF HARDWOOD LUMBER DISTRICT OF CAIRO, ILL.

ing a new location, are almost innumerable. Take the lumber interests, for example: The idea prevails to some extent that Illinois is one vast prairie. This is erroneous. It is sixty miles north of Cairo to the first small prairie and one hundred miles to the vast plains devoted to agriculture only. The region south of the prairies is still more than half-covered with heavy timber. There are luxuriant forests, consisting of various species of oak, black and white walnut, white and yellow poplar, hard and soft maple, black and red gum, ash, hickory, sycamore, cottonwood, sassafras, mulberry, and red cedar, all readily accessible to railroads. Then the States adjacent, Missouri, Arkansas, Kentucky and Tennessee all have vast forests—yet virginal in their luxuriance—of the same kinds of timber, easy of access by river or rail.

Next in importance to the supply of raw material for manufactories is fuel. It is not an exaggeration to say that a large portion of Southern Illinois is one vast coal field; mines being successfully worked in probably a hundred places, in deposits that range from three to nine feet in thickness.

The facilities for drawing on these almost virgin forests for timber and on the coal mines for fuel have already attracted the attention of capitalists from the great manufacturing centers. More than a dozen large woodworking concerns are in successful operation, and probably as many more have eyes longingly fixed on Cairo as a Mecca to which discerning business men must sooner or later journey.

As an illustration of the growth of the lumber business during the past few years, the following is a synopsis taken from the official records of the Lumber Exchange, showing the actual quantity handled each year:

1889	9,000,000 ft.
1890	25,000,000 ft.
1891	40,000,000 ft.
1892	100,000,000 ft.
1893	126,000,000 ft.
1894	200,000,000 ft.
1895	230,000,000 ft.
1896	300,000,000 ft.
1897	365,000,000 ft.
1898	400,000,000 ft.
1899	450,000,000 ft.

Cairo is the largest cottonwood market in the world, and is one of the leading hardwood centers of the United States.

Cairo is now recognized as one of the leading railroad centers of the middle West. Entering the city from the North is the famous Illinois Central, with its double-track system; the Mobile & Ohio, running direct from St. Louis, and the C., C., C. & St. L., or Big Four system. Coming from the South there are the Southern divisions of the Illinois Central and Mobile & Ohio, both of which cross the Ohio River on the magnificent steel bridge, the finest structure of its kind in the United States, and the largest, with one exception, in the world. From the West, crossing the Mississippi River on transfer boats, which carry whole trains of cars at each trip, are the Missouri Pacific (the Iron Mountain and Southern), and the St. Louis & Southwestern (Cotton Belt route). Then, too, there is the Chicago & Eastern Illinois, a new road, which crosses Alexander County and connects with the St. Louis Southwestern at Thebes, coming into Cairo over the Mobile & Ohio tracks. These give railroad facilities unexcelled anywhere, affording means of rapid communication with any point in the country.

Cairo has the finest inland harbor in the United States, with seven miles of river front, where the water is never less than thirty feet deep. This city is recognized as being at the head of deep-water navigation.

Cairo has a larger number of arrivals and departures of steam vessels each year than any other inland river port in the United States. Low water and ice never interfere with river commerce south of this point.

With such facilities for commerce, and with such surroundings as it has in Illinois, Missouri, Arkansas, Kentucky and Tennessee, it is not surprising that, as the records show, Cairo has twice the trade of any city of its size in the Union. The annual shipments by rail and river aggregate a sum approximating one hundred million dollars, about equally divided between the two and consists of wheat, grain, produce and coal to the South, and lumber and other finished timber products to the North, East and West.

It is estimated that about five million dollars are invested here in such business as banking, flour, grain, iron and heavy hardware, groceries, dry goods, etc. The city is exceptionally well provided with banking facilities, having four solid, sub-

WORTHINGTON CO.

EPISCOPAL CHURCH

CITY NATIONAL BANK

PAEPCKE-LEICHT CO. PLANT

NEW PLANT OF THE THREE STATES LUMBER CO.

VIEWS OF THE HARDWOOD LUMBER DISTRICT OF CAIRO, ILLINOIS stantial banks—two National and two Savings banks, with aggregate deposits of about two million dollars.

In the way of postal facilities Cairo is far ahead of any city of its size in Illinois. The local post-office is the best equipped of any in the State, outside of Chicago; every part of the city is covered by an efficient free delivery system and the importance of the city was recognized by the Department in making it and Chicago the only places in the State for the inauguration of the new system of registration of letters by letter-carriers. There are in connection with the main office, two stations where stamps and postal supplies may be purchased in large quantities, and where money order or registry business may be transacted. The sale of postage stamps, envelopes, etc., for the year 1899, amounted to nearly $27,000.00.

The United States has erected a large and handsome building here for federal purposes, at a cost of $300,000.00.

The location of Cairo has been officially recognized as a healthy one by the United States government, which has erected here one of the finest Marine Hospitals in the country. Regarding this the Surgeon-General, in a communication to the Secretary of the Treasury, writes:

"It has been my frequent duty to inspect the port of Cairo, Ill., to study its sanitary laws and to discuss and to direct its military hygiene. As a result of my observations and experience, I am prepared to assert that it is quite as healthful as any other place in the Union."

In addition to the Marine Hospital above alluded to, there is St. Mary's Infirmary, a very large, handsome building, skillfully and scientifically managed by the Sisters of the Holy Cross. It cares for city patients and for private individuals who may desire experienced nursing when ill, and for those who suffer from accidents on the numerous lines of railroads centering here.

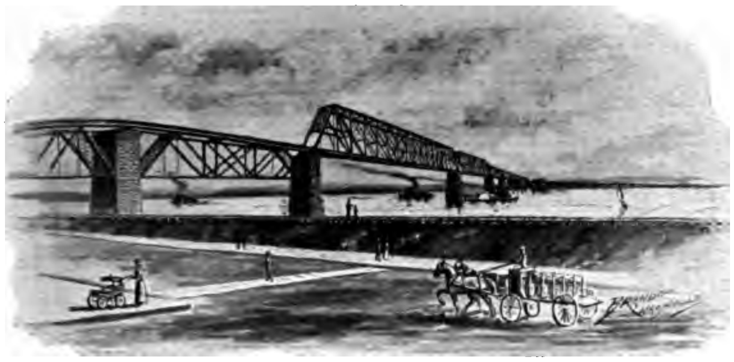
Probably no city in the West is better supplied with water and light than Cairo. There is a magnificent system of water-works, erected at a cost of more than $200,000.00. It has about twenty miles of mains, ranging in size from twenty-four inches down to six inches in diameter, and has a capacity of two million gallons daily, or enough for a city of 60,000 inhabitants. The water is obtained from the Ohio River. Within the past few years several artesian wells have been sunk in various parts of the city, with gratifying success. Water as clear as crystal and chemically pure, has been found in inexhaustible quantities. This discovery will be especially valuable in the manufacture of paper, and the attention of paper manufacturers has been drawn to it.

In the way of light and power, the city has two finely equipped electric companies, the Cairo and the Egypt, both of which operate street cars which cover all parts of the city and suburbs; both furnish light and power, and both are controlled by home capital.

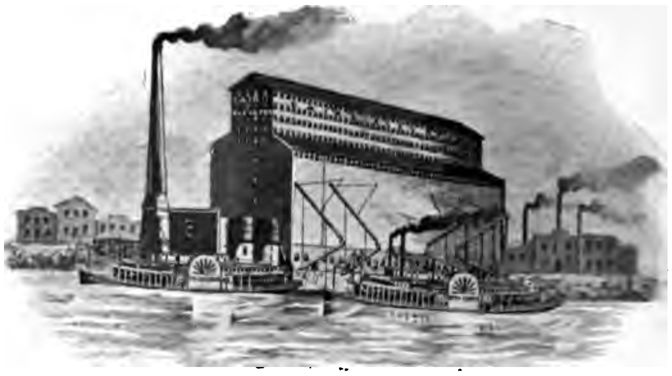
Immediately north of the city is another practical illustration of the success of the levee system. It is a drainage district, embracing some eight thousand acres of land, which had for centuries been annually overflowed by both rivers, leaving a deposit of alluvium unsurpassed in richness. This ground is now protected by a system of levees similar to that which incloses the city proper. Through the energy of the drainage commissioners this district has also been supplied with pumps like those used by the city, and the result has been that the entire district has not only been protected from inundation, but is relieved from the accumulation of rain and sipe water during periods of a prolonged stage of high water in the rivers. Much of this ground has been sold outright, much has been leased, and it is only a question of a few years when every foot of it will be under cultivation; mainly by market gardeners, who will be able to send their products to Northern and Eastern markets early in the season and reap large returns.

Few cities of its size can boast of more handsome churches than Cairo. Notable among them are the Church of the Redeemer (Episcopal), St. Patrick's and St. Joseph's (both Catholic), the First Methodist, the Presbyterian, the Cairo Baptist and the Calvary Baptist, besides nearly a dozen others of less pretension, including quite a number of really handsome edifices owned by colored people of different denominations.

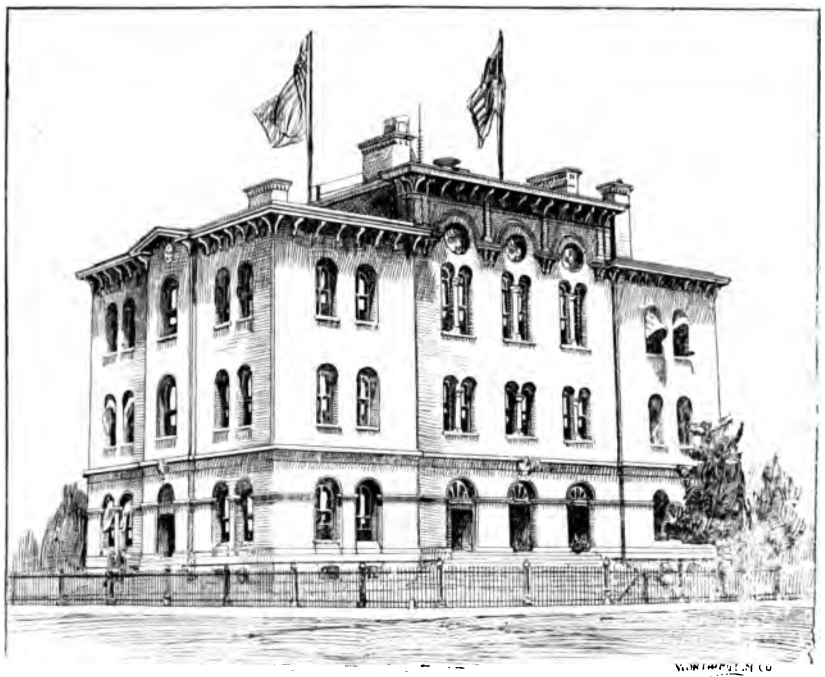
Cairo proudly boasts of her public school system and school buildings. The latter would be a credit to any city. The more prominent of these are the Douglas, the Safford, the Lincoln and the Cairo High School buildings. The latter, a new edifice, just erected at a cost of $30,000.00, is one of the most complete of its kind in the State. Then, there are the Sumner and Garrison schools, both



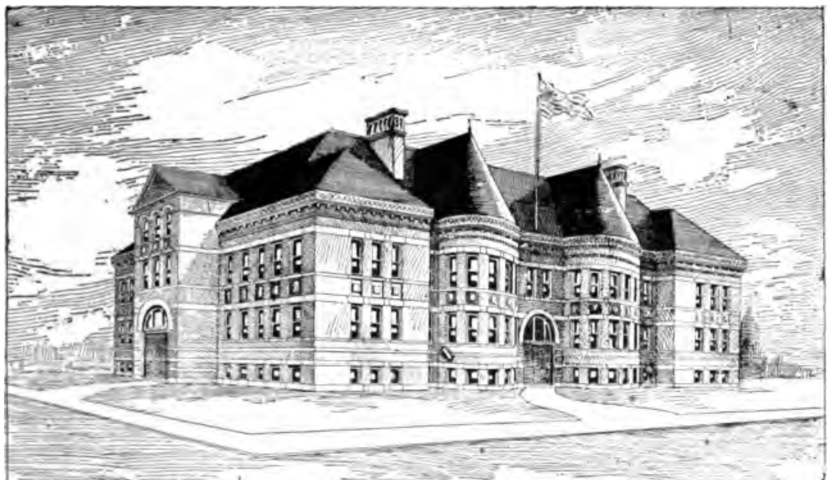
ILLINOIS CENTRAL RAILROAD BRIDGE AT CAIRO



CAIRO ELEVATOR

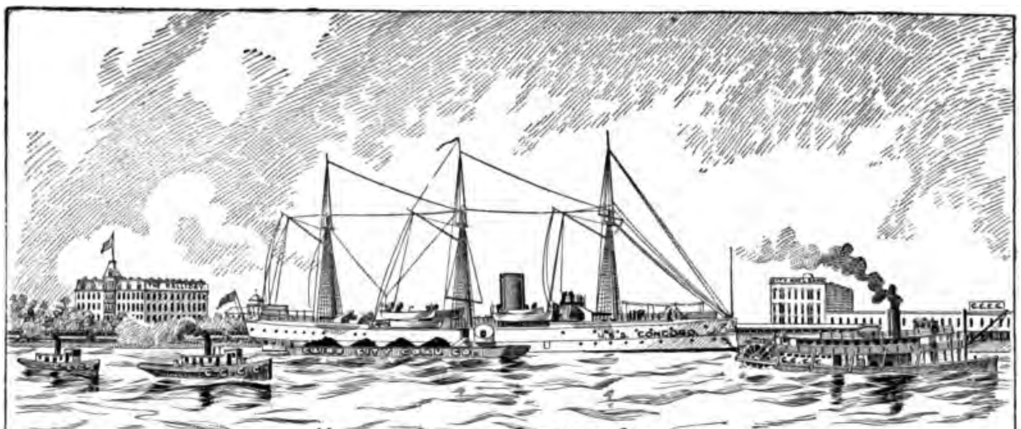


UNITED STATES CUSTOM HOUSE

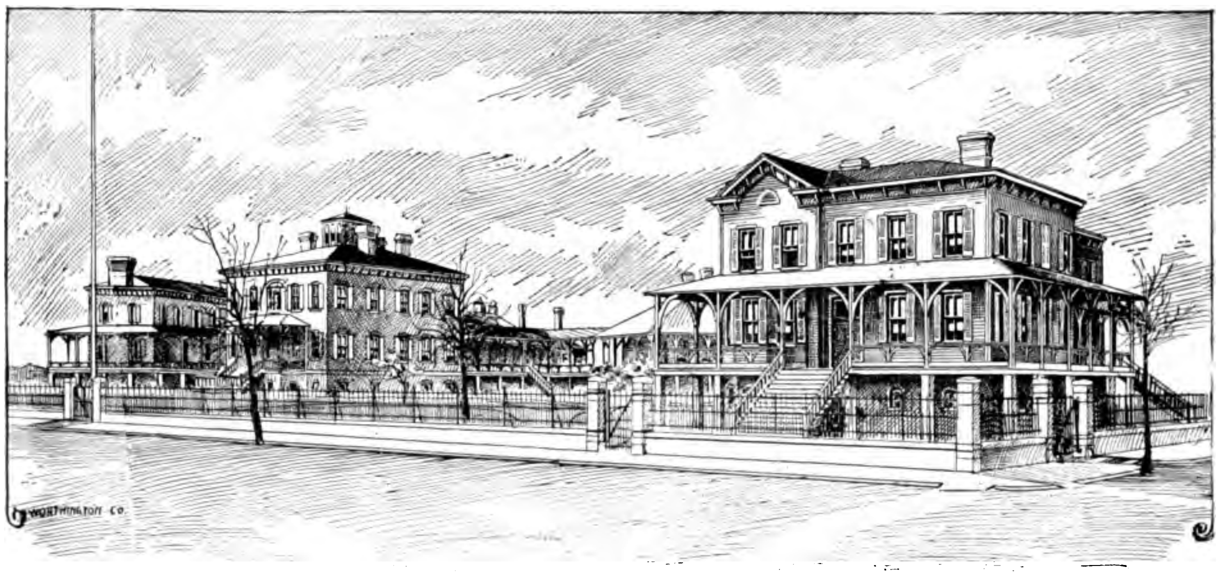


CAIRO HIGH SCHOOL

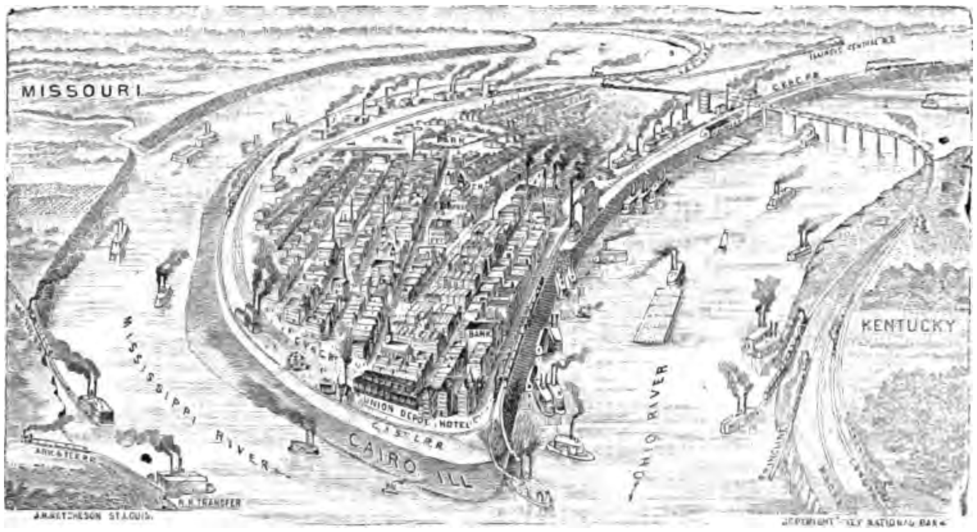
SAFFORD LIBRARY



UNITED STATES CRUISER CONCORD
IN CAIRO HARBOR, MAY 16TH TO 19TH 1892


WORTHINGTON CO.

UNITED STATES MARINE HOSPITAL



BIRD'S-EYE VIEW OF CAIRO, ILLINOIS

THE H. L. HALLIDAY MILLING COMPANY PLANT

THE HALLIDAY
C. Taylor
Nat'l Eng. Co. Washington D.C.

HALLIDAY HOTEL

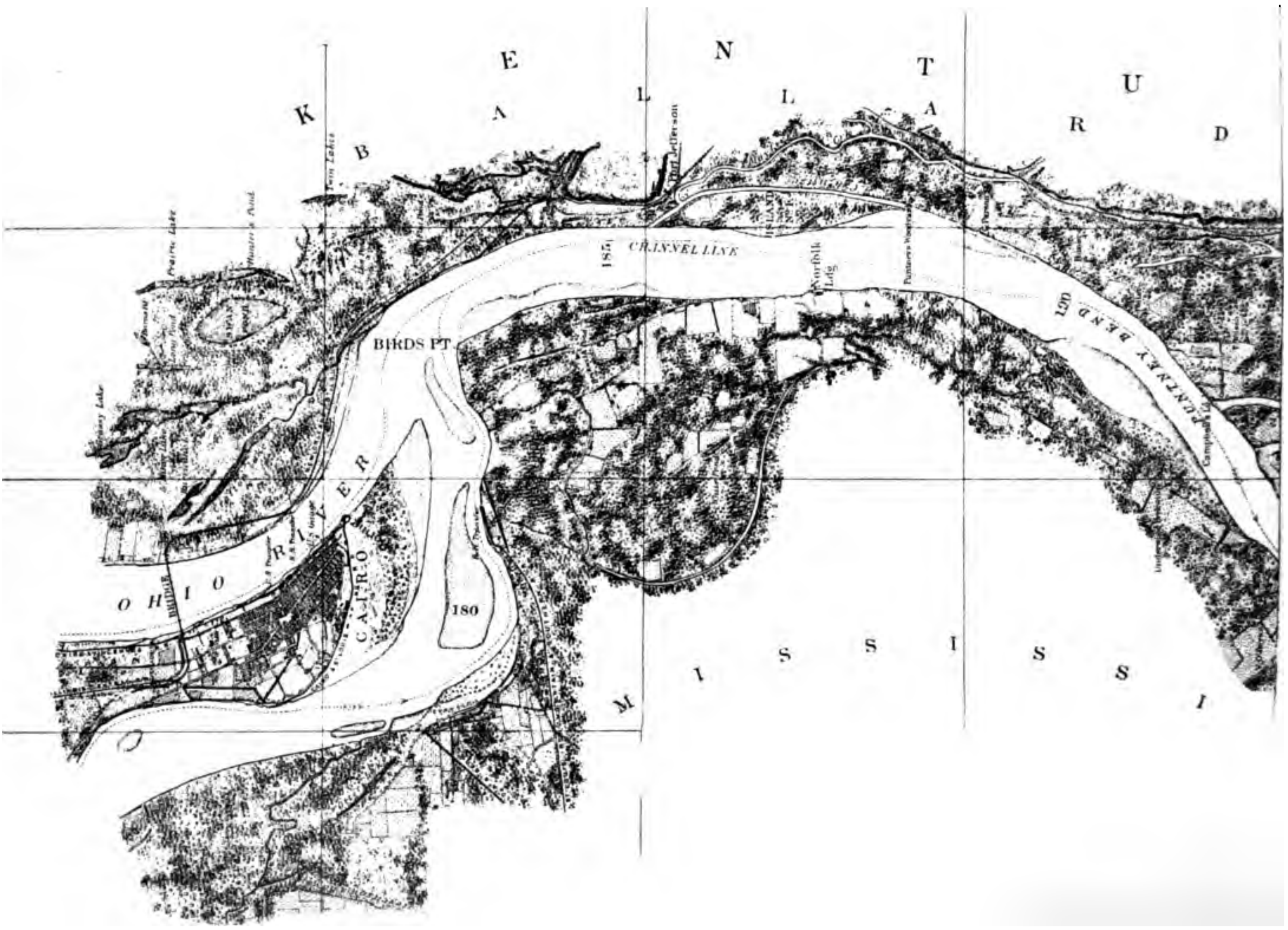
very handsome buildings, devoted exclusively to the free education of colored pupils. In addition to the free schools, there are quite a number of private and parochial schools, the most noted of which is Loretto Academy, under the management of the Sisters of Loretto.

In addition to the churches and school houses, mention should be made of the Safford Memorial Library, a magnificent building erected at a cost of $50,000.00 by Mrs. Anna E. Safford as a memorial to her husband, A. B. Safford, who, in life, was one of Cairo's most public-spirited citizens, and given to the city for public library purposes. This building now contains more than ten thousand volumes which are accessible to every one. It has also a public reading room, a museum and music, or reception, hall.

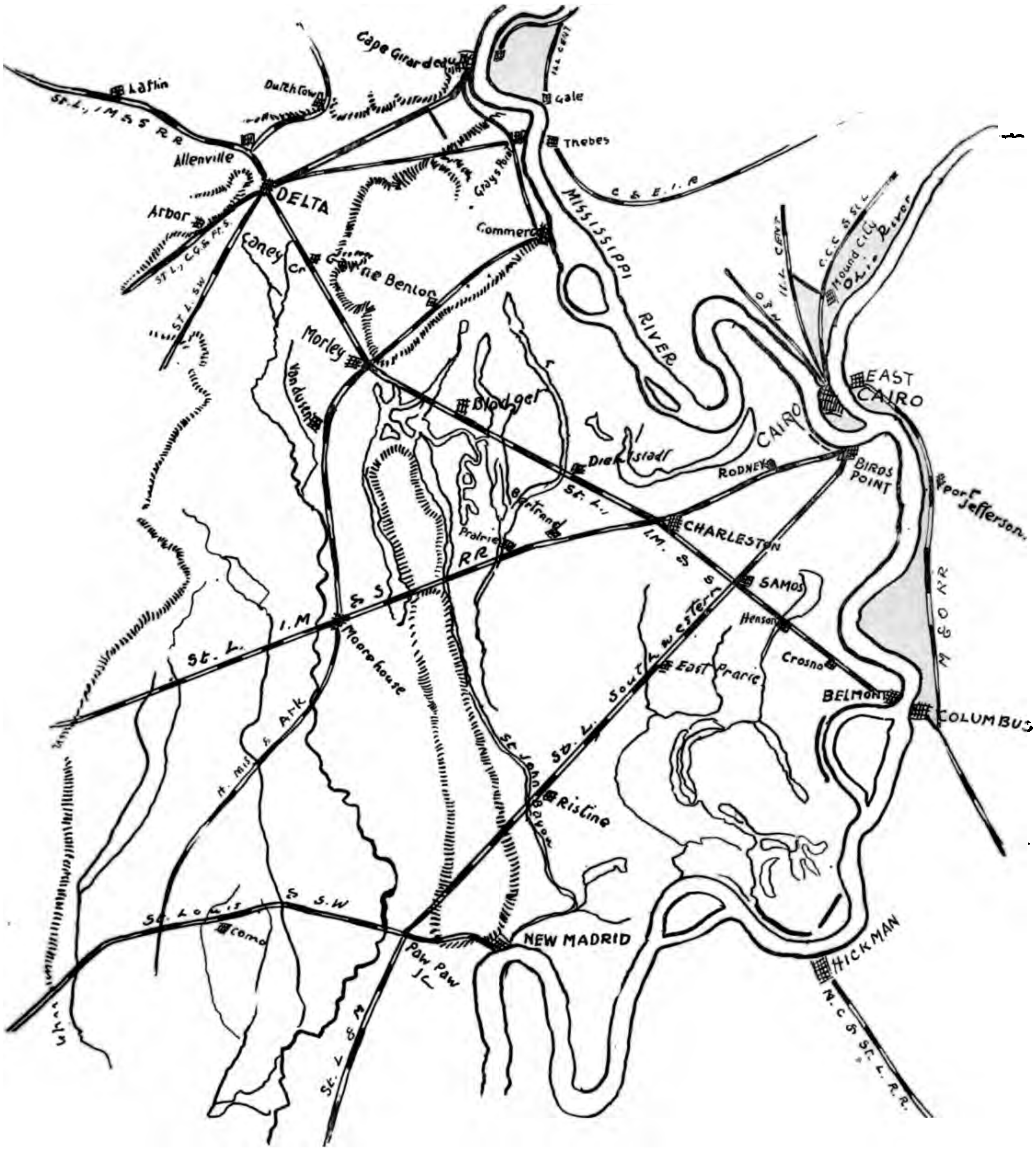
Cairo's future prospects are brilliant. The Board of Trade and Merchants' League, organizations devoted solely to the city's prosperity, are in constant communication with individuals and corporations seeking locations here. Several of the railroad companies are planning a new union depot, which will probably be erected in the near future. A new grain elevator of enormous capacity has just been erected by the H. L. Halliday Milling Co.

No article descriptive of Cairo would be complete without a mention of the late Capt. W. P. Halliday. In life he was one of the city's stanchest friends. No labor in her interests was too arduous for him to undertake, no expense for her welfare or promotion too great for him to assume. Numerous monuments to his far-seeing sagacity exist to-day and will exist for centuries to come.

In conclusion, it may be truthfully said that no city in the Mississippi Valley has reaped greater benefits from the levee system than has Cairo, and there is no city in the West that has more brilliant prospects for the future, especially following the development of contiguous alluvial districts in Missouri, Kentucky, Tennessee and Arkansas, when they have been made safe by a permanent system of levees.



THE MISSISSIPPI AND OHIO RIVERS AT CAIRO—"WHERE THE RIVERS MEET"



THE ALLUVIAL BASINS IN MISSOURI ABOVE THE ST. FRANCIS BASIN

Missouri

ALLUVIAL LANDS IN MISSOURI

Assessed valuation in the alluvial and partly alluvial counties of Missouri :

COUNTIES	1880	1890	1899
Cape Girardeau	$4,034,538	$4,449,178	$5,547,196
Mississippi	1,295,657	2,106,418	2,770,128
New Madrid	1,193,854	1,638,067	2,246,160
Stoddard	1,581,113	2,326,117	4,222,380
Pemiscott	818,888	1,040,276	2,150,407
Butler	889,775	2,298,159	3,403.543
Dunklin	889,530	2,118,871	3,118,237

The alluvial lands in Missouri lie in the counties of Cape Girardeau, Scott, Stoddard, Butler, Dunklin, Mississippi, New Madrid and Pemiscott. The first three are only partially alluvial; Dunklin, Mississippi, New Madrid and Pemiscott wholly so.

According to the measurements of the Mississippi River Commission, there are in this state 2,874 square miles, or 1,839,360 acres, of overflow lands.

The alluvial lands in this State are divided into two basins by the high lands, but of initial alluvial formation at New Madrid, that above New Madrid forming a separate basin from that below. The lower forms a part of the St. Francis basin, which lies in Missouri and Arkansas.

There are three counties which are regarded as forming this basin—New Madrid, Pemiscott and Dunklin. Much of the alluvial lands in this State is above overflow, forming ridges and high lands that lie between the sections which are overswept. Besides, the floods in that section of the alluvial valley recede, usually, before crop season begins, and thus those who dwell on ridges are enabled to make crop on lands which otherwise would remain idle. But even with these advantages it was necessary for improved levee conditions to begin this active development. Now, the county of Pemiscott may be cited as an example of this statement. In 1880 its population was 4,299. In 1890 it was 5,975. In 1900 it is 12,111, thus showing an increase in size to three times that of twenty years ago, and more than double that of ten years ago.

Since 1880 an equally wonderful showing is made in the assessed valuation shown by these strictly alluvial counties. Take first Cape Girardeau county. This county had in 1880 an assessed valuation of $4,034,538. Last year this valuation had increased to $5,547,196. This was not more than a normal increase for the state of Missouri; neither is Cape Girardeau very much alluvial—some in the extreme southern portion; and its development was not retarded by floods prior to the present time. Mississippi county in 1880 showed an assessed valuation of $1,295,657. In 1899 a total assessment of $2,270,128 shows that it has doubled these figures. This county is nearly all alluvial. New Madrid county, which is all alluvial, but which has been retarded in growth by the absence of a complete levee system, still shows an increase from $1,193,854 in 1880 to $2,246,160 in 1899, or nearly double. Over two-thirds of this has accumulated within the last nine years. Stoddard county shows a remarkable increase—from $1,581,113 in 1880 to $4,222,280 in 1899.

As is seen by the summary given above, the increase in the strictly alluvial counties has been almost entirely within the last nine years, or since the levee system became more secure.

Pemiscott county, which in 1880 had an assessed valuation of $818,888, showed a growth up to 1890 of about $200,000 in assessed valuation, but in 1899, nine years later, it had more than doubled the assessed valuation of 1890; that is, it had increased its valuation in the last nine years five times as much as it did in the first ten years preceding. This is one of the best exemplifications of the benefit of a levee system to the growth of the country. Butler county has figures exceeding these, where, from $889,775 on the rolls in 1880, it has increased to $3,403,543. Dunklin county nearly parallels it in the rapidity of its growth.

In addition to the growth caused by natural development following improved levee conditions, the railroads have done much to hasten development. The magnificent timber interests of this section have drawn railroads hither until there are several new lines built through Pemiscott, New Madrid, Dunklin and Stoddard. These roads are the Houck system of roads, the Paragould & Eastern Railroad, the St. Louis, Memphis & Caruthersville, the main lines and branches of the St. Louis, Iron Mountain & Southern, and the St. Louis Southwestern roads.

In this section of the Mississippi River alluvial districts, and in the northern tier of the Arkansas counties, which lie back from the river, is found beautifully kept farms, on which are raised small grain and hay very similar to those of most of the northern prairie states, as illustrations accompanying this article show.

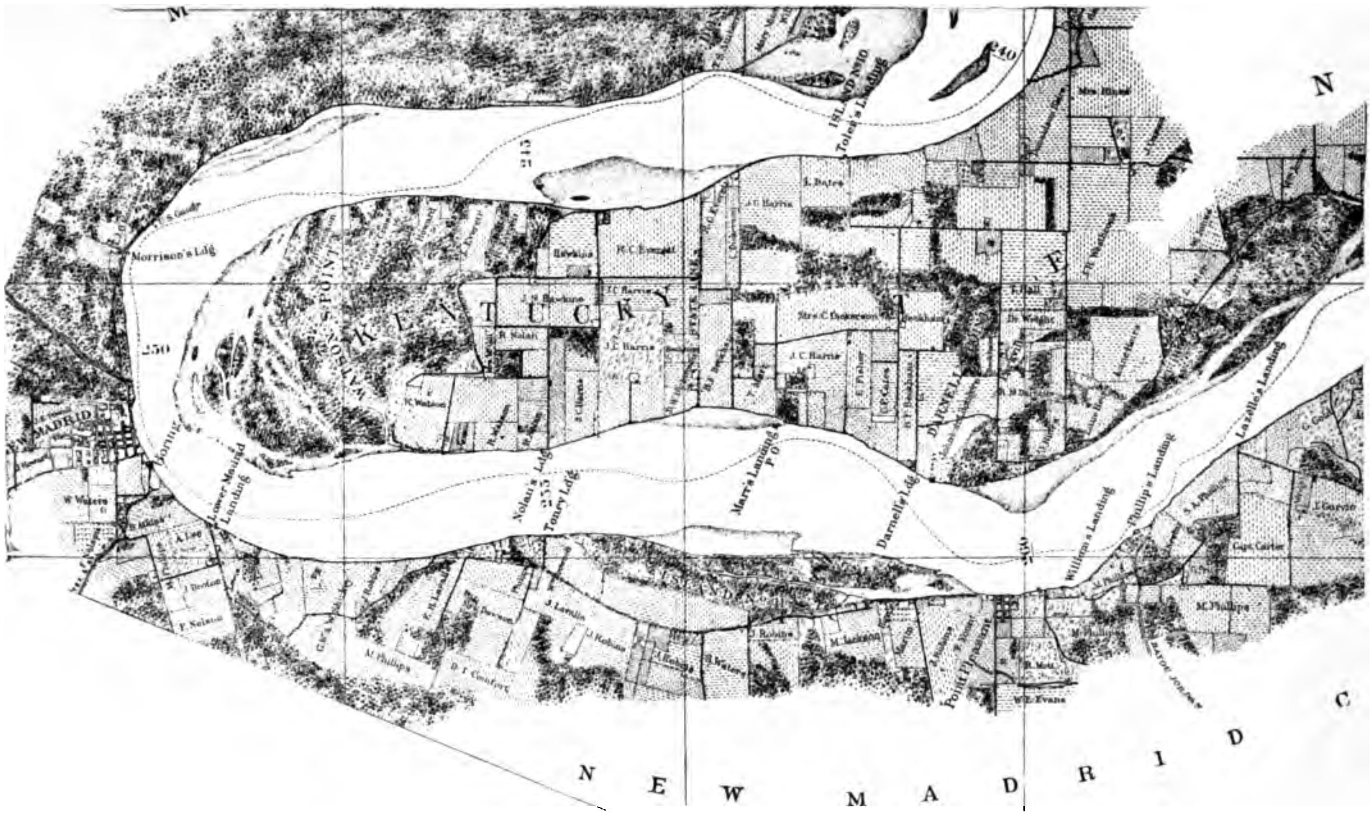
While the assessed valuation and population have both increased very rapidly in the last twenty years, it will be noted, as remarked above, and as is shown by the comparison of the increases between the two decades, this increase has been much more rapid of late years. No doubt, with perfect immunity from water, these counties will over double, and many of them will probably quadruple, their present assessed valuation and population in the next decade.

Caruthersville, in Pemiscott county, is one of the most remarkable examples of the improvement in growth and facilities in this section. A few years ago it was simply an isolated town on the Mississippi River, without any especial claims to notice. Now it has stave factories and heading factories, sawmills, one of which has a capacity of one hundred thousand feet a day; ice plant of ten tons' capacity; a school building, heated by steam, costing $13,000; a very fine courthouse, and a two-story brick jail, costing $8,000. It has two banks—the Bank of Caruthersville, with a capital of $30,000, and the Pemiscott County Bank, with a capital of $25,000. It has two railroads—the St. Louis, Caruthersville & Memphis, and the St. Louis, Kennett & Southern—and others are reaching out in that direction. It has two newspapers—the Daily Press and the Democrat, which is printed twice a week. It has the largest wholesale hardware store between Memphis and St. Louis on the west side of the river. Its present population is 2,315. Situated in the midst of a rapidly growing county, advancing both in wealth and population, and con-

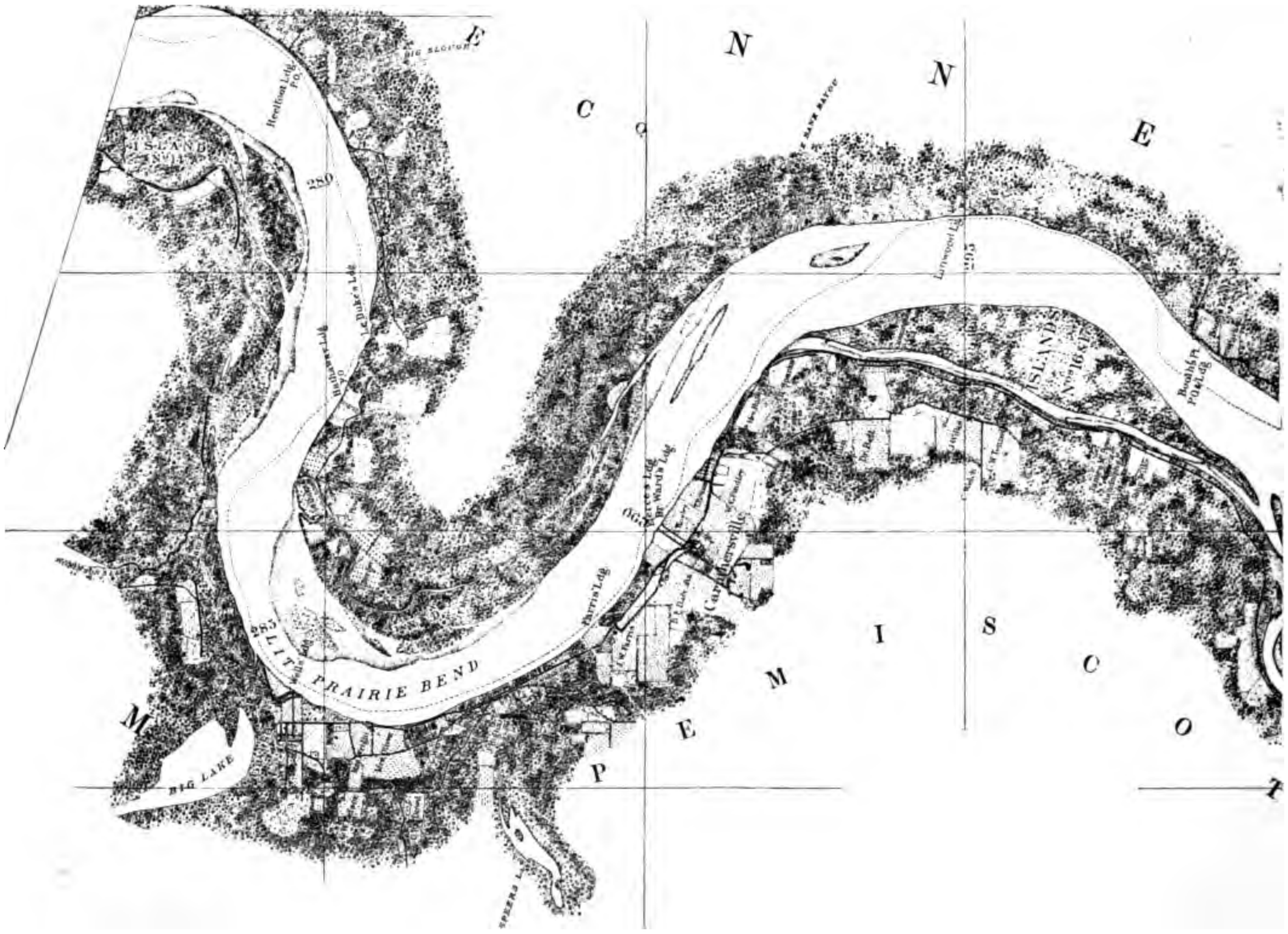
LON V. STEPHENS
Governor of Missouri

DAVID R. FRANCIS
Ex-Governor of Missouri

WILLIAM J. STONE
Ex-Governor of Missouri



THE MISSISSIPPI RIVER AT NEW MADRID, MO.

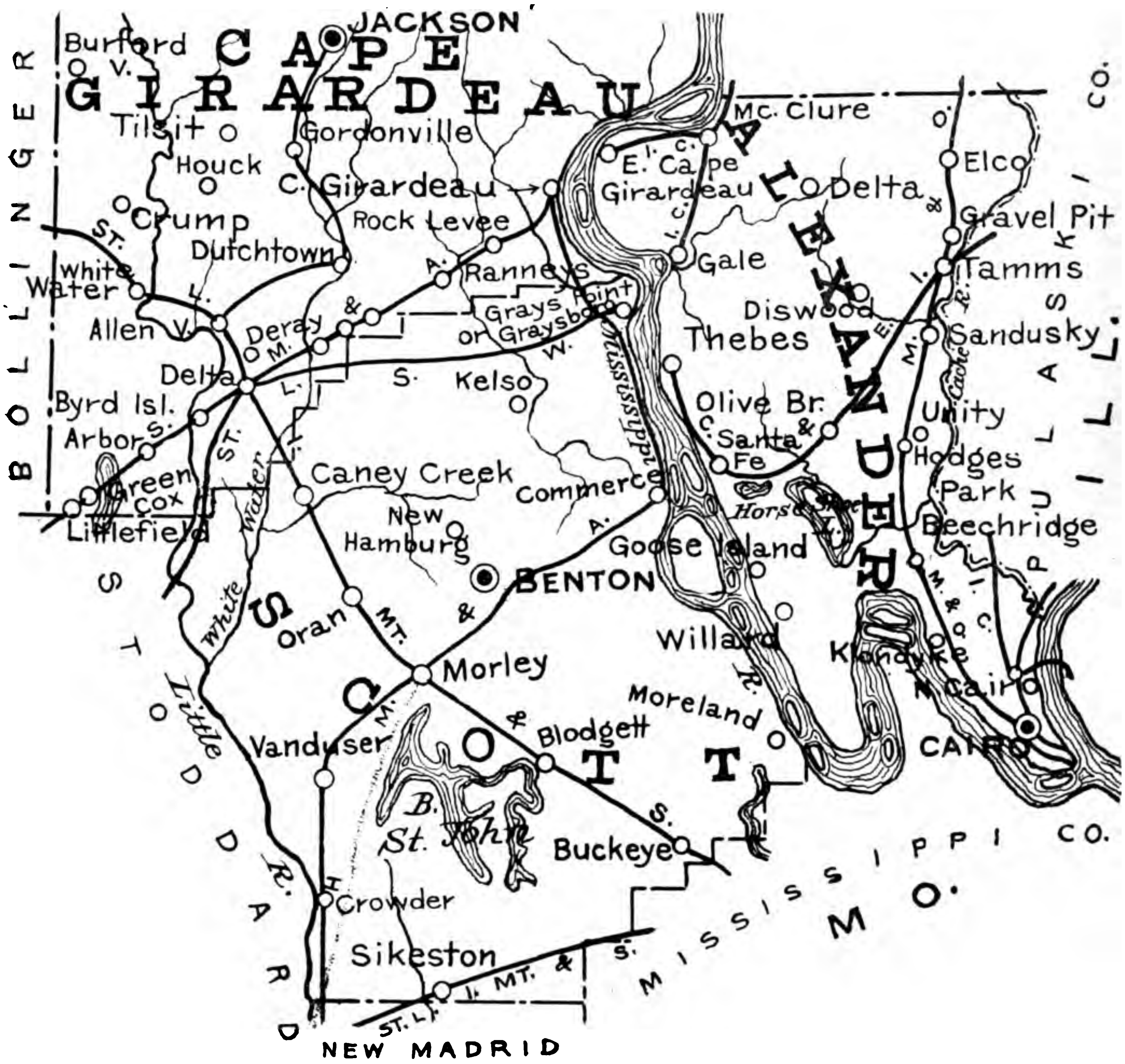


THE MISSISSIPPI RIVER AT CARUTHERSVILLE, MO.

nected by these railroads with rich counties in the rear, and equally rich counties on the south, in Arkansas, it has every prospect of showing a more rapid increase in the next census.

New Madrid, in New Madrid, is a very old town, as it was laid out by Pierre Foucher in 1789. It occupied an irregular piece of ground lying between Bayou St. John and Bayou Desroches, and fronted the river on the southeast. Since the settlement of the town the Mississippi has made an annual encroachment upon it until now the original site lies about a mile from the bank on the Kentucky side. Addition upon addition has been made, only to be swallowed up; all the old landmarks have one by one succumbed to the devouring current, and New Madrid of to-day has nothing about it which suggests its origin. In November, 1808, New Madrid was incorporated. It did not, however, improve much until after the year 1822, when the seat of justice was permanently located here. Its first newspaper was printed in 1846. There are now two newspapers in the city—the Record and the Southeast Missourian. It has now several fine brick store buildings, two large school buildings, one for the white and one for the colored. It has a large stave factory, cotton gin, ... works, and electric light plant. Two railroads enter the city—branch of the St. Louis Southwestern (Cotton Belt) and the St. Louis & Memphis Railroad. A third is projected that will be built early in the spring. The present population is about 2,000. New Madrid is supported by a very rich surrounding country, and its industries and trade are built on substantial lines, and will no doubt show rapid increase in the next few years.

Other places in this rich alluvial belt which show rapid increases in size and industrial activity are Charleston, the county seat of Mississippi county; Hayti; Kennett, the county seat of Dunklin county, which is quite a new place, but a very prosperous one; Poplar Bluff, on the St. Louis, Iron Mountain & Southern, the county seat of Butler, which has 4,321; Cardwell, on the St. Francis River, and on the Paragould, Southeastern Railroad; Charleston, the county seat, which is situated on both the St. Louis Southwestern and the St. Louis, Iron Mountain & Southern Railroads; Minley, in Scott county, at the junction of three railroads; Moorehouse, on the borders of New Madrid and Stoddard counties; Portageville, in Pemiscott county. In fact, growing villages and towns have sprung up all through the alluvial sections of the state along lines of railroads which have been built through these sections. Maps are given in this connection which show the location of these cities and towns and also the location of the different lines of railroads. Figures accompanying each map show the population of these counties in 1880, 1890, and 1900, demonstrating a wonderful improvement in the last twenty years, as increase in population is a sure sign of commercial or industrial activity, or both.



CAPE GIRARDEAU, MO.

Taxable area	361,364
Assessed valuation, 1899	$5,547,196
" " 1890	4,449,178
" " 1880	4,034,538
Increase in 19 years	1,512,658

Population, see page 351

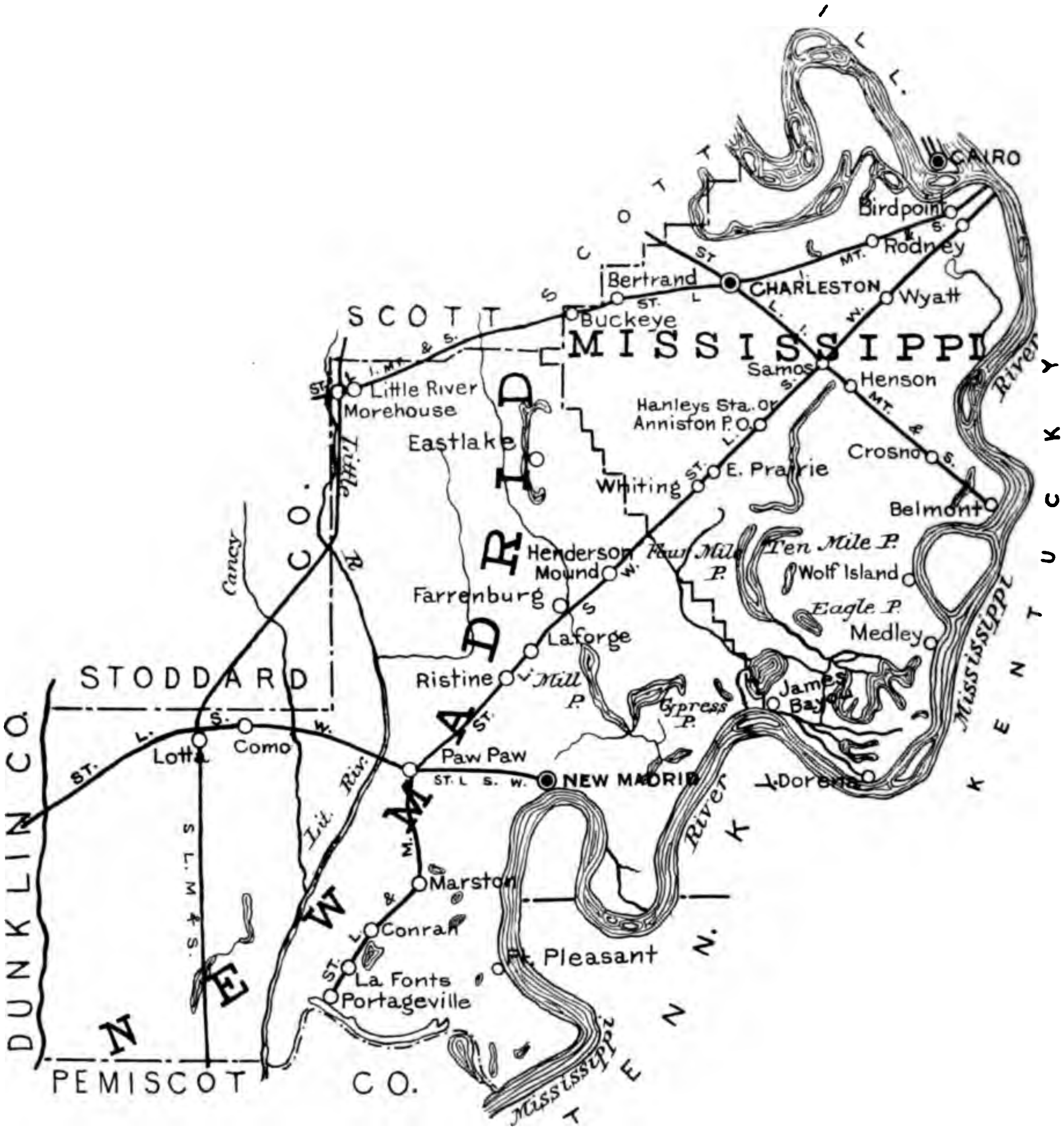
SCOTT COUNTY, MO.

Taxable area	260,365

Population, see page 351

ALEXANDER COUNTY, ILLS.

Population, see page 351



NEW MADRID COUNTY, MO.

Population, 1900		11,280
Assessed Valuation,	1899	$2,246,160
" "	1890	1,638,067
" "	1880	1,193,854
Increase in 19 years		1,052,306
Taxable Area (acres)		350,489

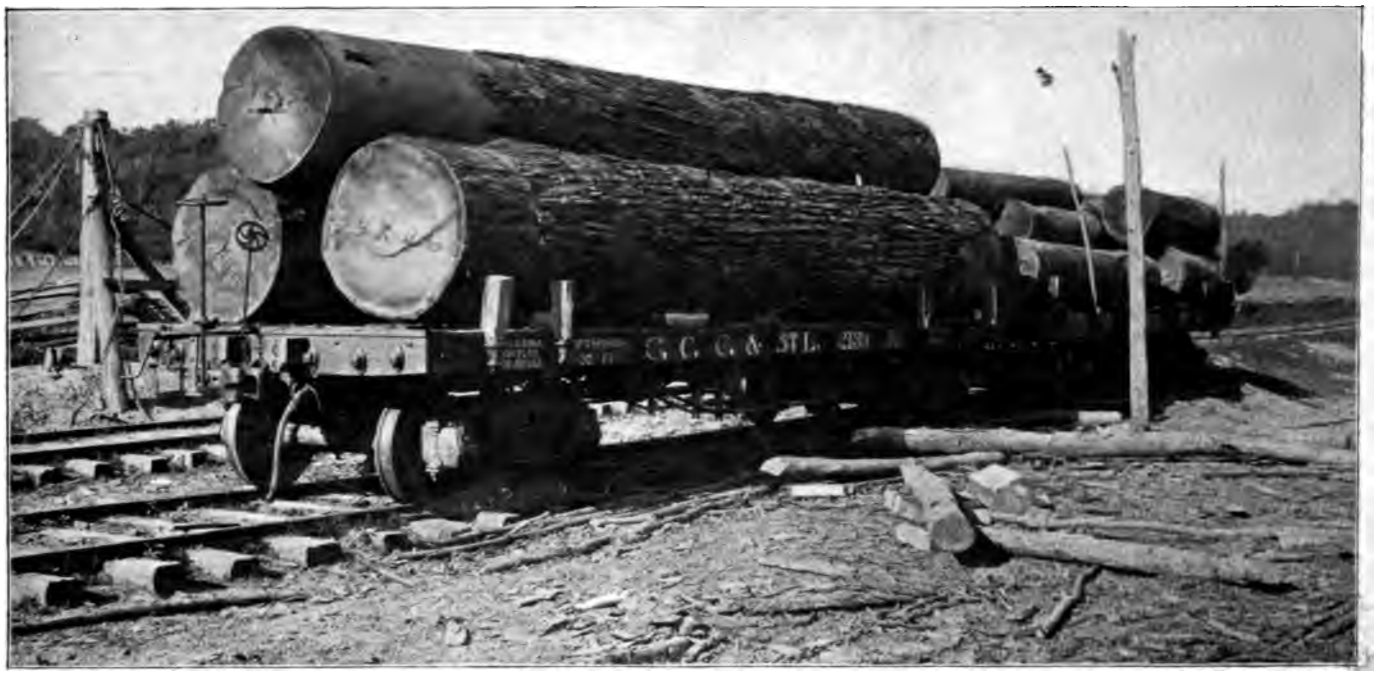
MISSISSIPPI COUNTY, MO.

Population, 1900		11,837
Assessed Valuation,	1899	$2,770,125
" "	1890	2,106,418
" "	1880	1,295,657
Increase in 19 years		1,474,468
Taxable Area (acres)		247,852

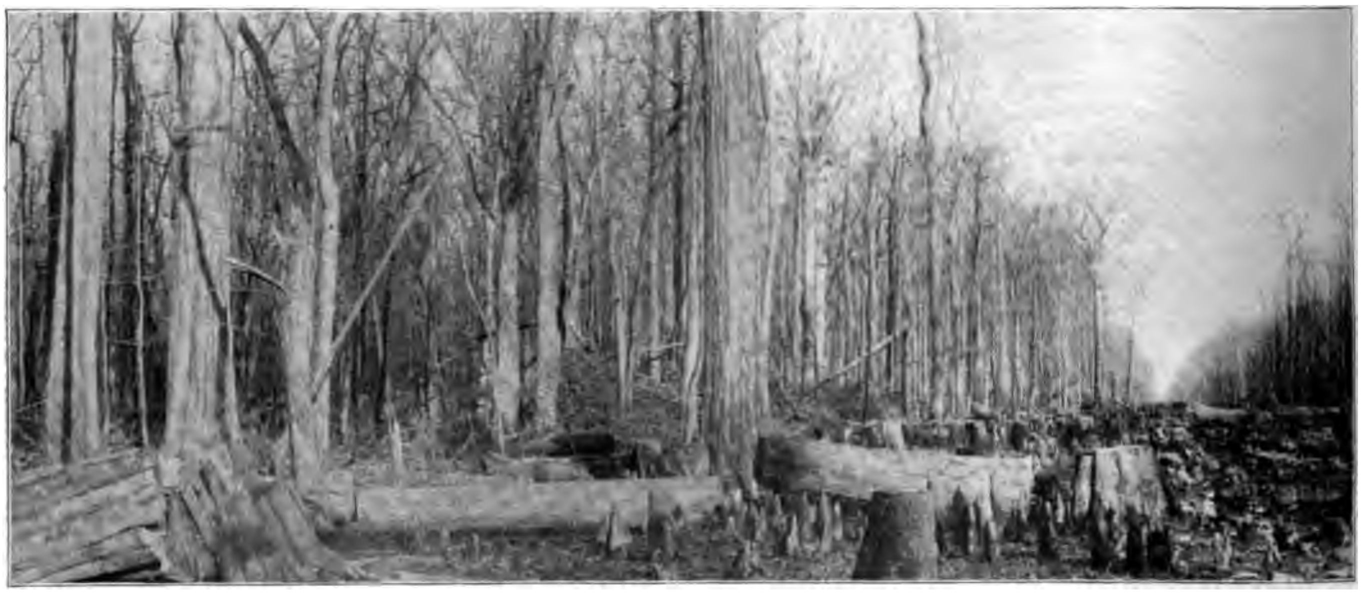
Population 1880, 1890, see page 351.

CULTIVATING AN ALLUVIAL FARM—STODDARD COUNTY, MO.

THE GOLDEN GRAIN AS GROWN ON THE RICH ALLUVIUM OF SOUTHEAST MISSOURI



THESE THREE LOGS MADE 11,000 FEET OF LUMBER CUT FROM FARM OF LOUIS B. HOUCK, ST. FRANCIS BASIN



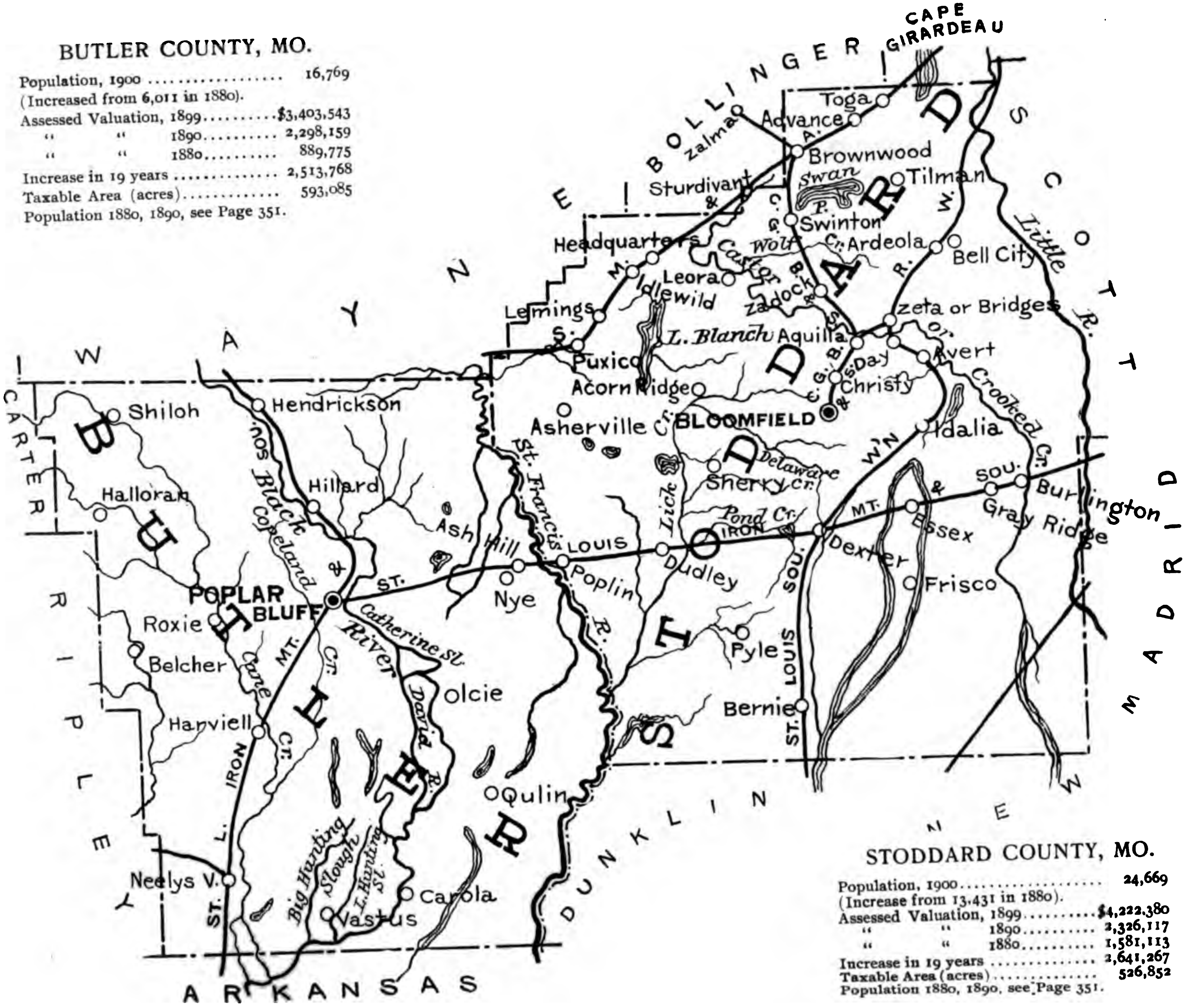
CUTTING RAILROAD ROUTE THROUGH A CYPRESS BRAKE, ST. FRANCIS BASIN

COURT HOUSE AT KENNETT, DUNKLIN COUNTY, MISSOURI.

SHIPPING COTTON—SCENE IN THE ST. FRANCIS BASIN

BUTLER COUNTY, MO.

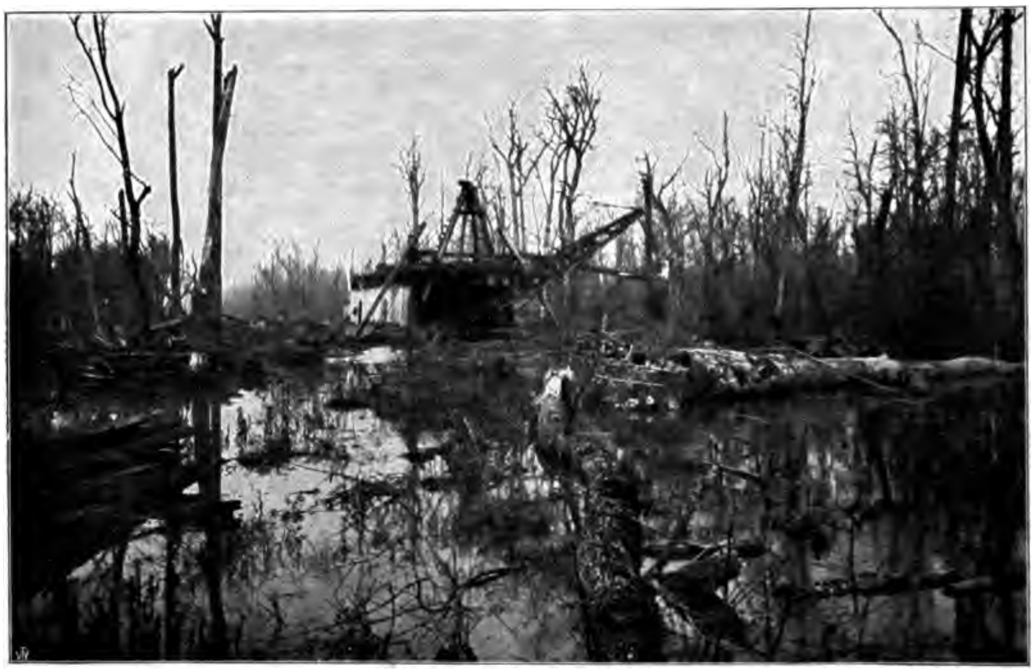
Population, 1900	16,769
(Increased from 6,011 in 1880).	
Assessed Valuation, 1899	$3,403,543
" " 1890	2,298,159
" " 1880	889,775
Increase in 19 years	2,513,768
Taxable Area (acres)	593,085
Population 1880, 1890, see Page 351.	



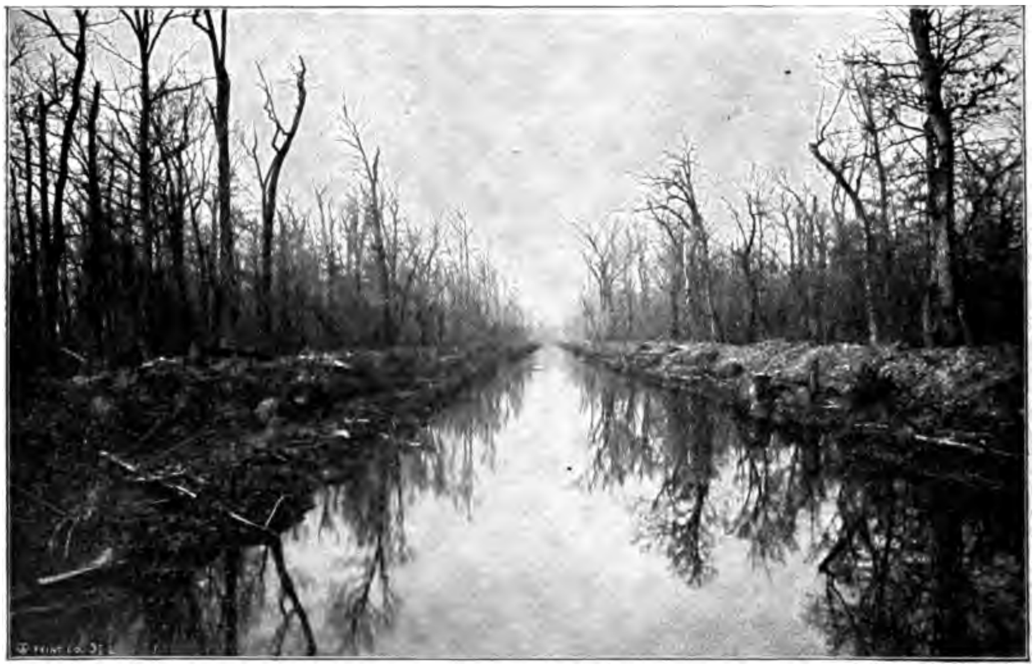
STODDARD COUNTY, MO.

Population, 1900	24,669
(Increase from 13,431 in 1880).	
Assessed Valuation, 1899	$4,222,380
" " 1890	2,326,117
" " 1880	1,581,113
Increase in 19 years	2,641,267
Taxable Area (acres)	526,852
Population 1880, 1890, see Page 351.	

HARVEST TIME IN SOUTHEAST MISSOURI—SCENES NEAR DEXTER, STODDARD COUNTY

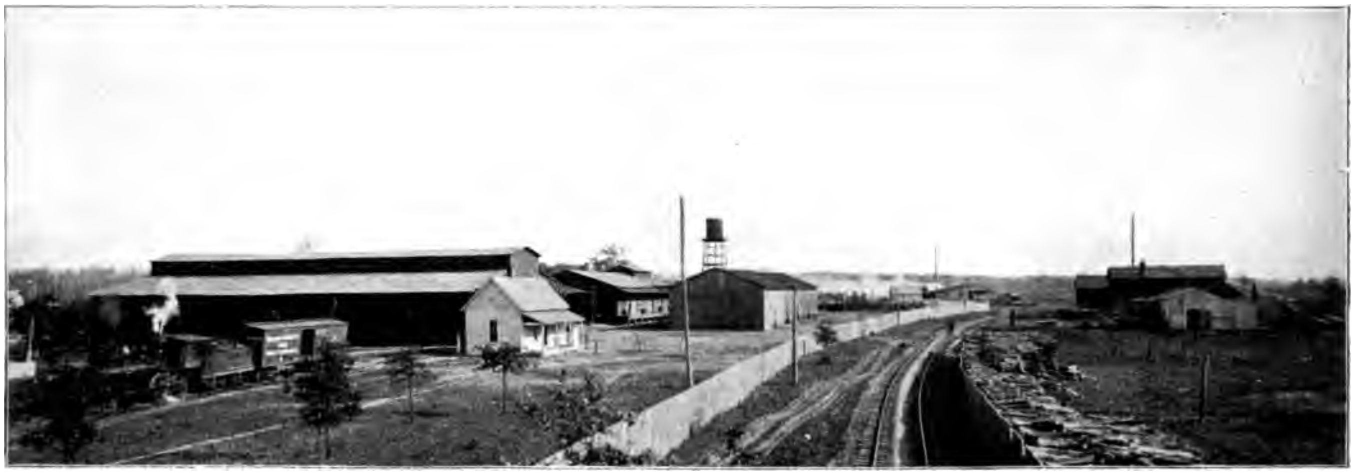


MAKING DRAINAGE CANAL, TO RECOVER SWAMP LANDS, NEAR MOOREHOUSE, NEW MADRID COUNTY, MISSOURI

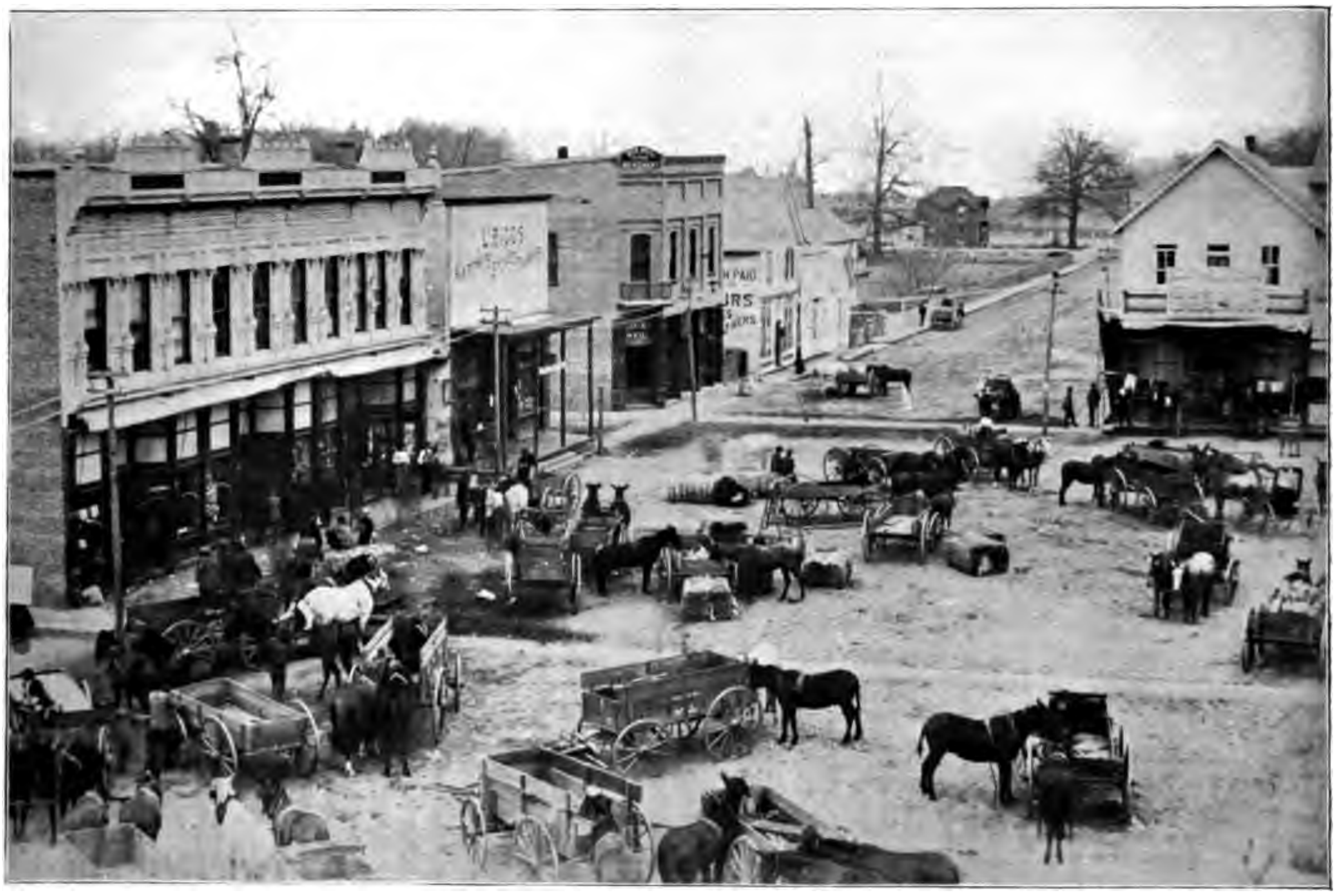


FINISHED DRAINAGE CANAL, THROUGH SWAMP LANDS, NEAR MOREHOUSE, NEW MADRID COUNTY, MISSOURI.

THE BUILDING-UP OF SOUTHEAST MISSOURI



RAILROAD YARDS AT KENNETT, MISSOURI



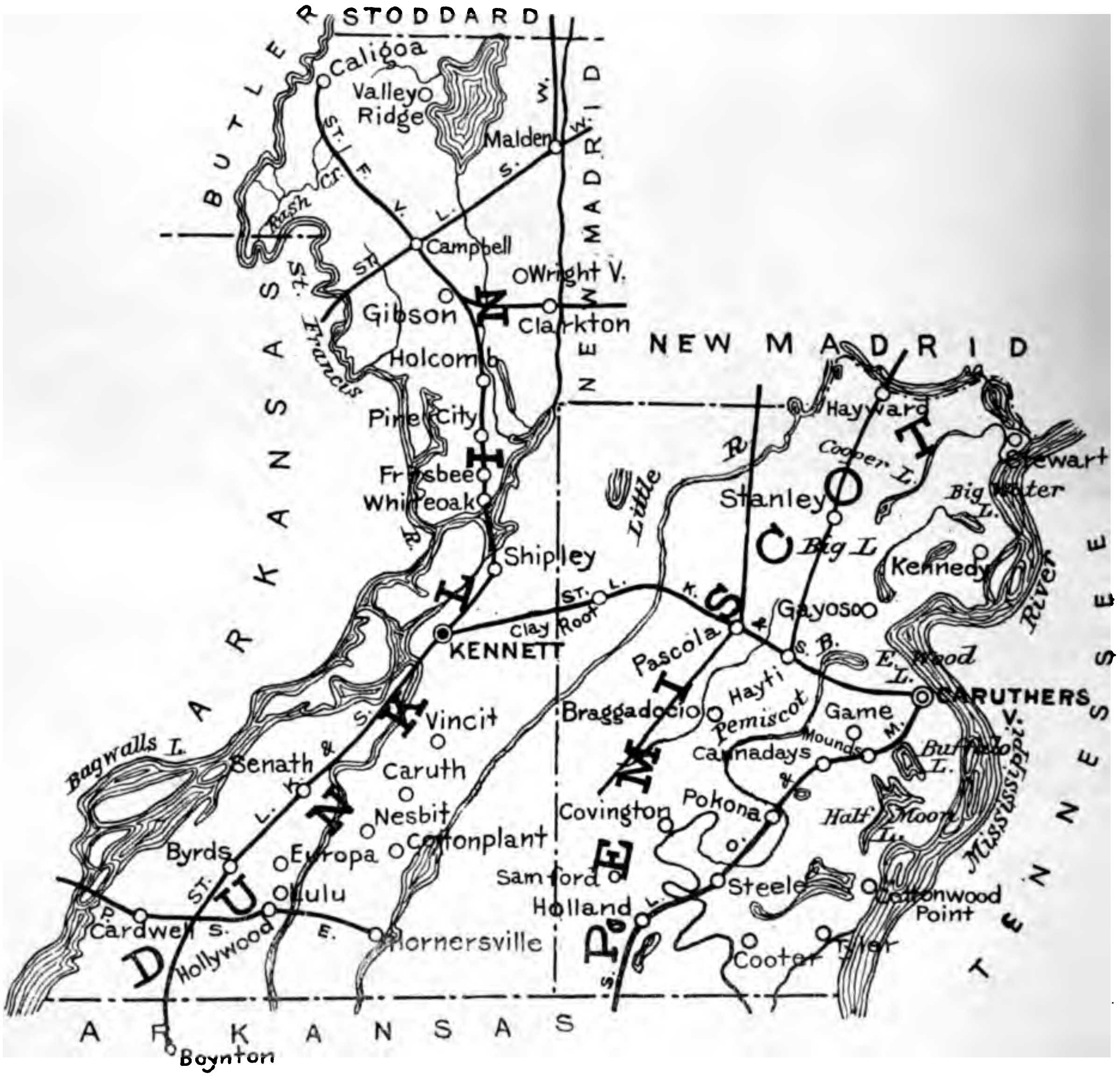
PUBLIC SQUARE AT KENNETT, MISSOURI, 1894

SCENES IN THE BUILDING-UP OF SOUTHEAST MISSOURI

BUILDING A NEW RAILROAD IN THE ST. FRANCIS BASIN

PILING TRAIN IN THE ST. FRANCIS BASIN

REAPING THE RESULTS—SCENES IN THE RICH BOTTOMS OF SOUTHEAST MISSOURI



DUNKLIN COUNTY, MO.

Taxable area, acres	247,218
Assessed valuation, 1880	$ 889,530
" " 1890	2,118,871
" " 1899	3,118,237
Increase in 19 years	1,228,707

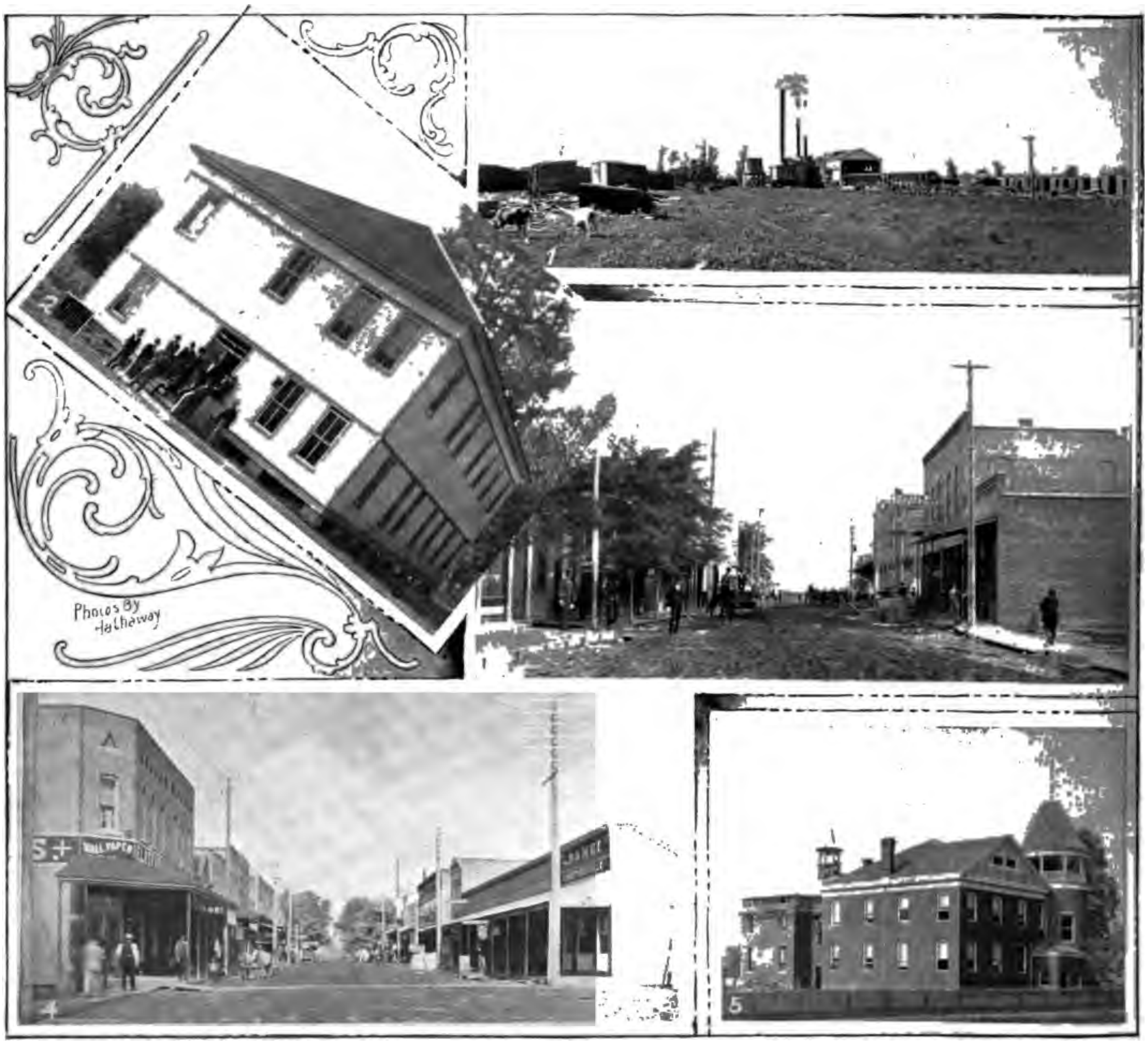
PEMISCOT COUNTY, MO.

Taxable area, acres	350,489
Assessed valuation, 1880	$ 818,888
" " 1890	2,298,159
" " 1899	3,118,237
Increase in 19 years	2,299,349

A RESIDENCE STREET AT KENNETT, MISSOURI

PUBLIC SQUARE, KENNETT, MISSOURI, 1899

VIEWS OF NEW MADRID, MO.



VIEWS OF CARUTHERSVILLE, MO.

GEO. W. MURPHY
Attorney-General of Arkansas

J. J. DOYNE
rintendent Public Education of Arkansas

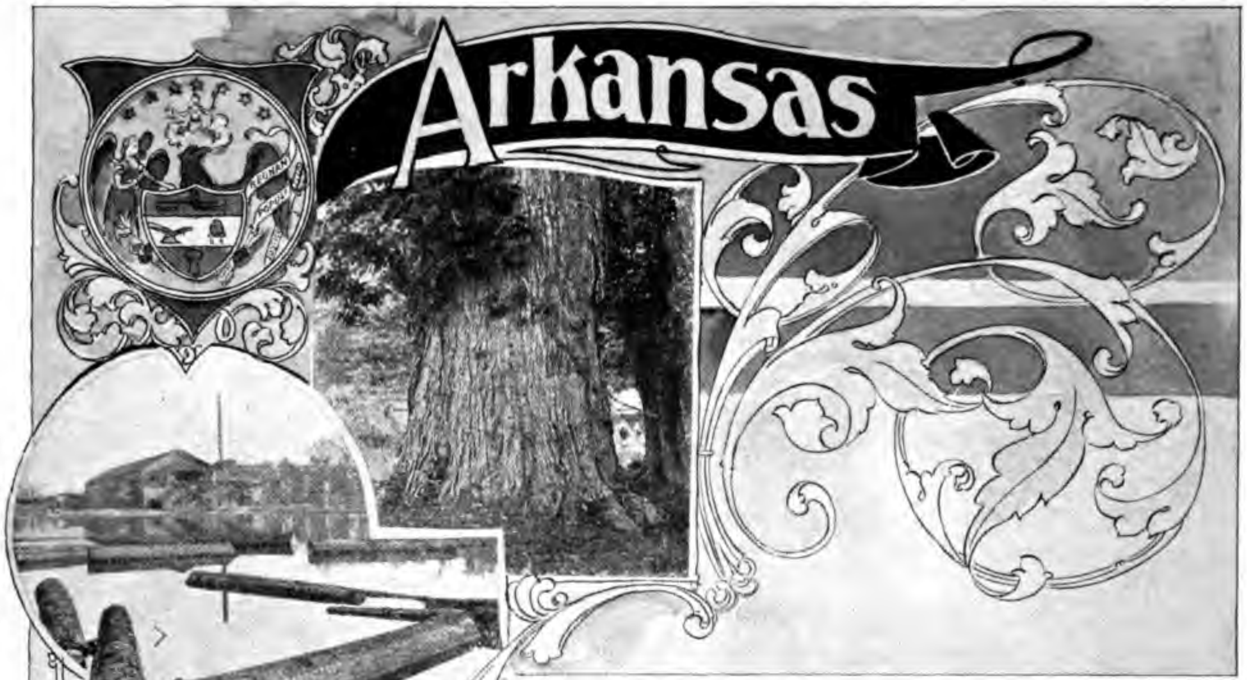
FRANK HILL
Commissioner of Agriculture, Mines and Manufactures

JEFFERSON DAVIS
Governor of Arkansas

T. C. MONCURE
State Auditor of Arkansas

JAMES P. CLARKE
Ex-Governor of Arkansas

THOS. E. LITTLE
State Treasurer of Arkansas



COUNTIES WHICH LIE PARTLY AND WHOLLY IN THE ALLUVIAL DISTRICTS OF ARKANSAS, ASSESSED VALUATION, AREA, ETC.

CLAY, GREENE, PULASKI, PHILLIPS, DESHA, JEFFERSON, CHICOT.

(For Population see Page 352.)

NOTE.—Statistics were not secured of the assessed valuation of the last-named counties, but mention is made of their progress in the general description.—ED.

ST. FRANCIS COUNTY

Total area	648 square miles (¾ alluvial)
Total assessed value, 1890	$2,540,291
" " " 1899	2,645,586

LEE COUNTY

Total area	600 square miles (¾ alluvial)
Total assessed value, 1890	$2,423,535
" " " 1899	2,538,645

CROSS COUNTY

Total area	600 square miles (¾ alluvial)
Total assessed value, 1890	$1,930,252
" " " 1899	2,330,350

CRAIGHEAD COUNTY

Total area	700 square miles (⅔ alluvial)
Total assessed value, 1890	$3,091,765
" " " 1899	4,179,010

POINSETT COUNTY

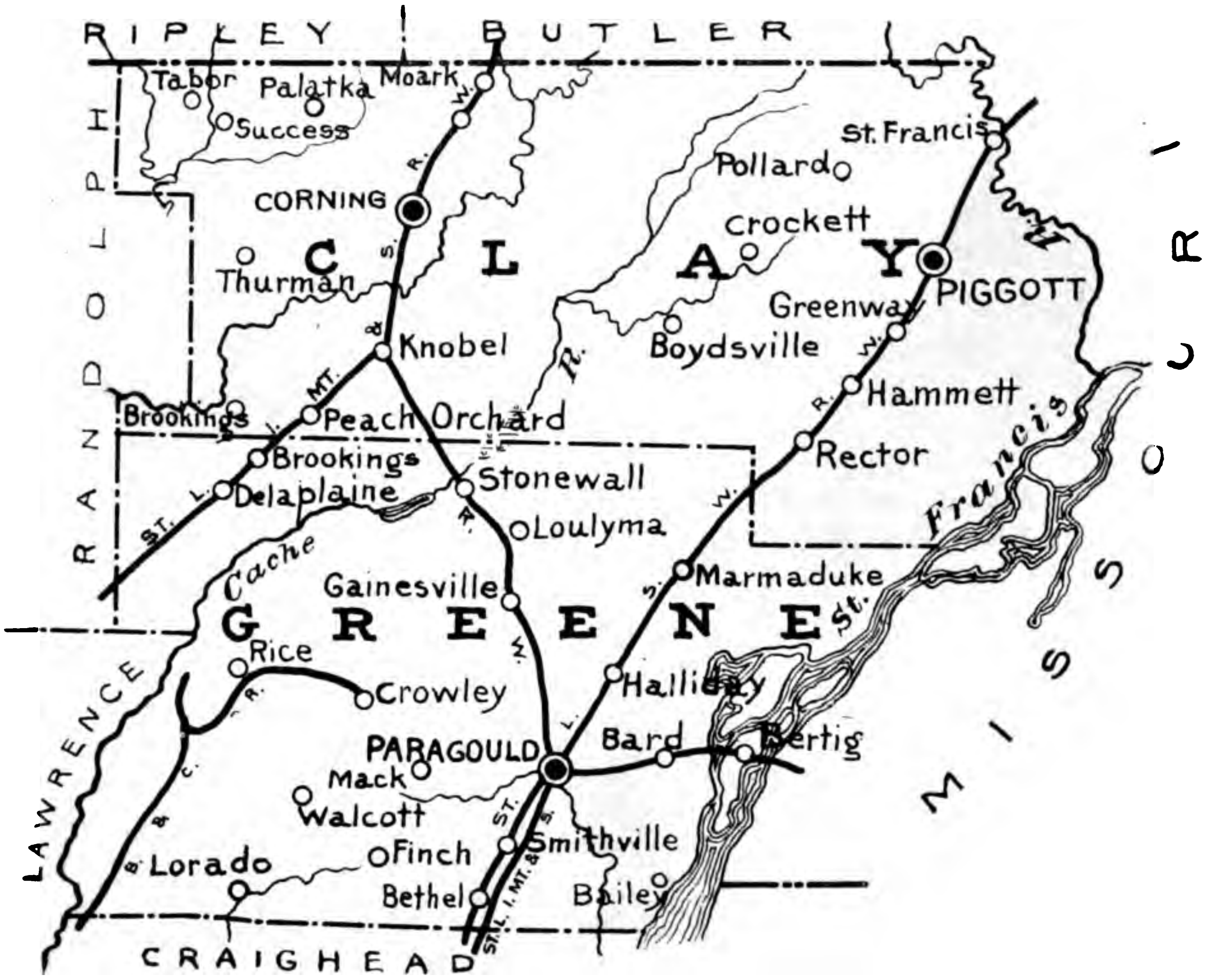
Total area	684 square miles (¾ alluvial)
Total assessed value, 1890	$1,686,731
" " " 1899	1,990,327

MISSISSIPPI COUNTY

Total area	800 square miles (all alluvial)
Total assessed value, 1890	$1,862,167
" " " 1899	2,232,270

CRITTENDEN COUNTY

Total area	600 square miles (all alluvial)
Total assessed value, 1890	$2,115,079
" " " 1899	2,811,953



CLAY AND GREENE COUNTIES,
ARKANSAS

(Size Reduced)

For Population, see page 352.

THE TREES GROWN IN THE RIPARIAN LANDS OF THE MISSISSIPPI RIVER

OPENING UP THE ALLUVIAL LANDS OF ARKANSAS

ALLUVIAL LANDS IN ARKANSAS

According to the surveys of the Mississippi River Commission, as shown in the large map which accompanies this publication, the entire number of square miles of Mississippi River alluvium, or rather of the overflow lands of the Mississippi River, is 4,625 square miles, or a total of 2,960,000 acres. In addition to these lands there is alluvial soil of the Arkansas River, and White River, which is not counted in this total. It is quite safe to say that the entire alluvial districts of the state of Arkansas would approximate 6,000 square miles.

In the northern part of the state, and in the outlying sections back from the rivers, there is cultivated considerable grain, and raising of cattle is largely the occupation of the people.

The great staple crops of these alluvial sections are corn and cotton, and even the former is not raised in sufficient quantities for home consumption. It may be an error of judgment and developing a lack of conservative farming practice, but it nevertheless is a fact that the people of the alluvial sections of the Mississippi River depend on cotton —buy their meat, their meal, and much of their corn, which is unusual in a farming community.

The present condition of the great alluvial basins in Arkansas is shown by the fact that the development in that section is not over twenty per cent. In the northern and western portions of the Mississippi River bottom, in the upper St. Francis basin, it will probably exceed that amount, but lower down, in the White River basin, and in the upper Tensas, which is just above the Louisiana line, this estimate would be entirely too great. So of these 2,960,000 acres there is probably yet untouched by the plow 2,500,000 acres, a very large amount of which is heavily timbered, and practically all of it is fertile and well-drained.

Eastern Arkansas has, besides the Mississippi River, which forms its boundary line, separating it from Tennessee and Mississippi, the White, St. Francis, Black and Cache rivers draining the upper basin, and the lower White and Arkansas Rivers in the lower basin.

The railroads which traverse these alluvial sections are the Missouri Pacific system, (St. Louis, Iron Mountain & Southern), Cotton Belt; Houck system of railroads; St. Louis, Caruthersville & Memphis; Kansas City, Ft. Scott & Memphis, the Choctaw, Oklahoma & Gulf, Arkansas Midland; Mississippi River; Hamburg & Western; Deckersville, Osceola & Northern; Brinkley & Helena; and Batesville & Brinkley, and a few others which touch the alluvial sections at different points. The St. Louis, Iron Mountain & Southern division of the Missouri Pacific, and the St. Louis, South Western (Cotton Belt), have branch lines running into nearly all of the different basins.

Thus the facilities for marketing the productions of these basins are good, and new railroads and new branches of existing systems are being built or projected in different directions, influenced, no doubt, by the present fairly satisfactory levee conditions, and the growing conviction that overflows will soon be a thing of the past.

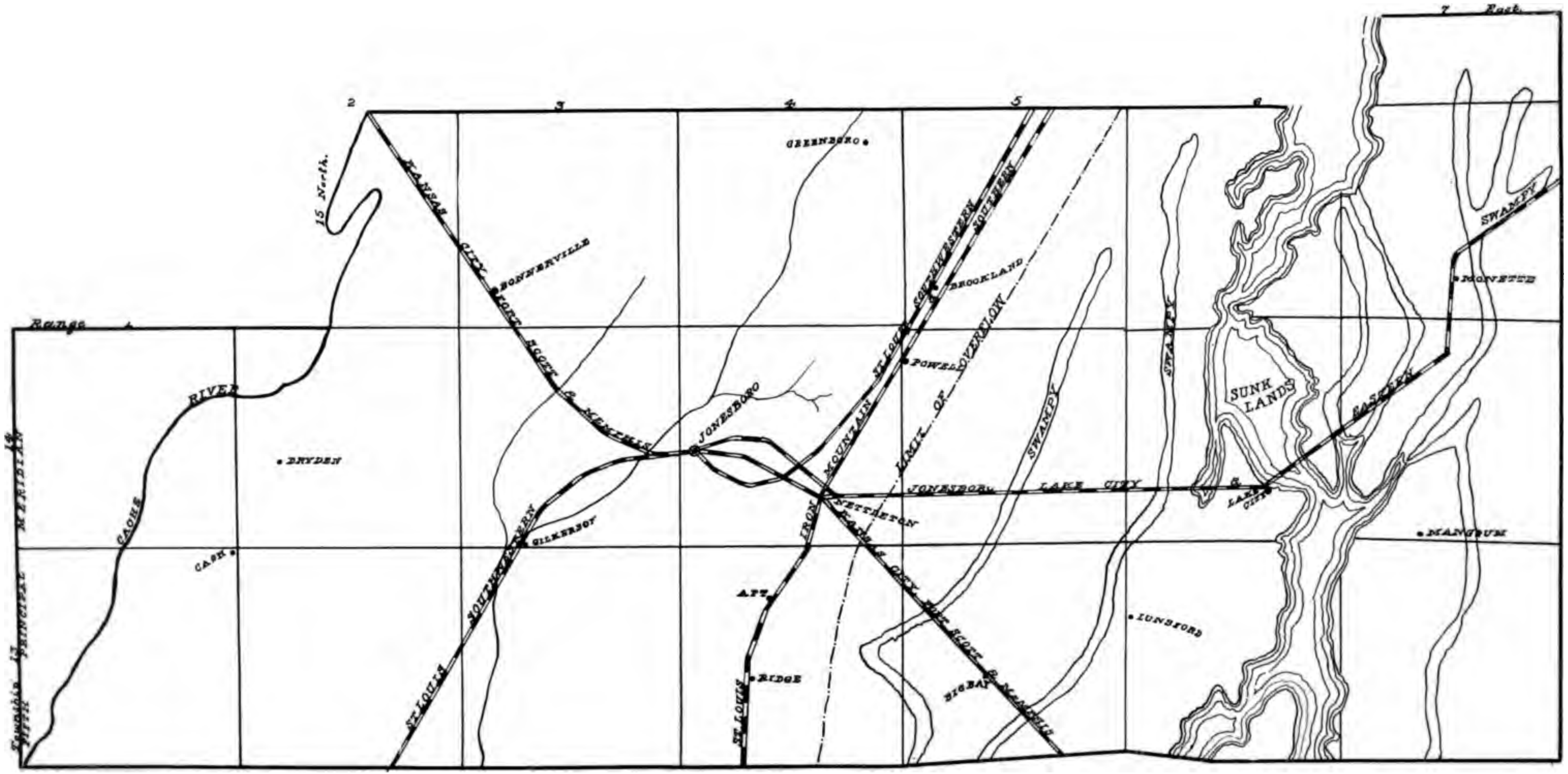
The average yield of cotton in these rich "bottoms" is fully 1,500 pounds of seed cotton per acre. Corn and oats produce in proportion.

In the lighter lands sweet potatoes, turnips, sorghum, Irish potatoes, and all kinds of garden truck are successfully grown, and the careful farmer nearly always has an abundance of these for his own use, and some to market when he goes to his nearest town. This, of course, applies to the smaller farmers. The larger plantation owners raise these things only for home use, and too frequently pay so much attention to King Cotton that these products are overlooked.

Arkansas is a great fruit state, especially for apples. These, however, are raised mostly in the hill sections of the northwestern portion of the state, but the climate and soil in the alluvial section are eminently suitable for the successful raising of all kinds of fruit; and not only can they raise all kinds of fruit but, owing to the extreme fertility of these lands they attain an unusual perfection in size and flavor.

The lands which have been cultivated and become worn, or at least as near worn as the extraordinary depth and fertility of this soil will permit, are sometimes planted in grasses, and these grow luxuriantly.

The climate of this part of Arkansas is so equable and the density of the cane brakes so great that thousands of cattle roam the bottoms and thrive all the winter long without being fed. In fact there are numerous instances where even the finest grades of short-horn cattle have been successfully wintered with the use of only small quantities of cotton seed, and at trifling expense. Cattle raising,

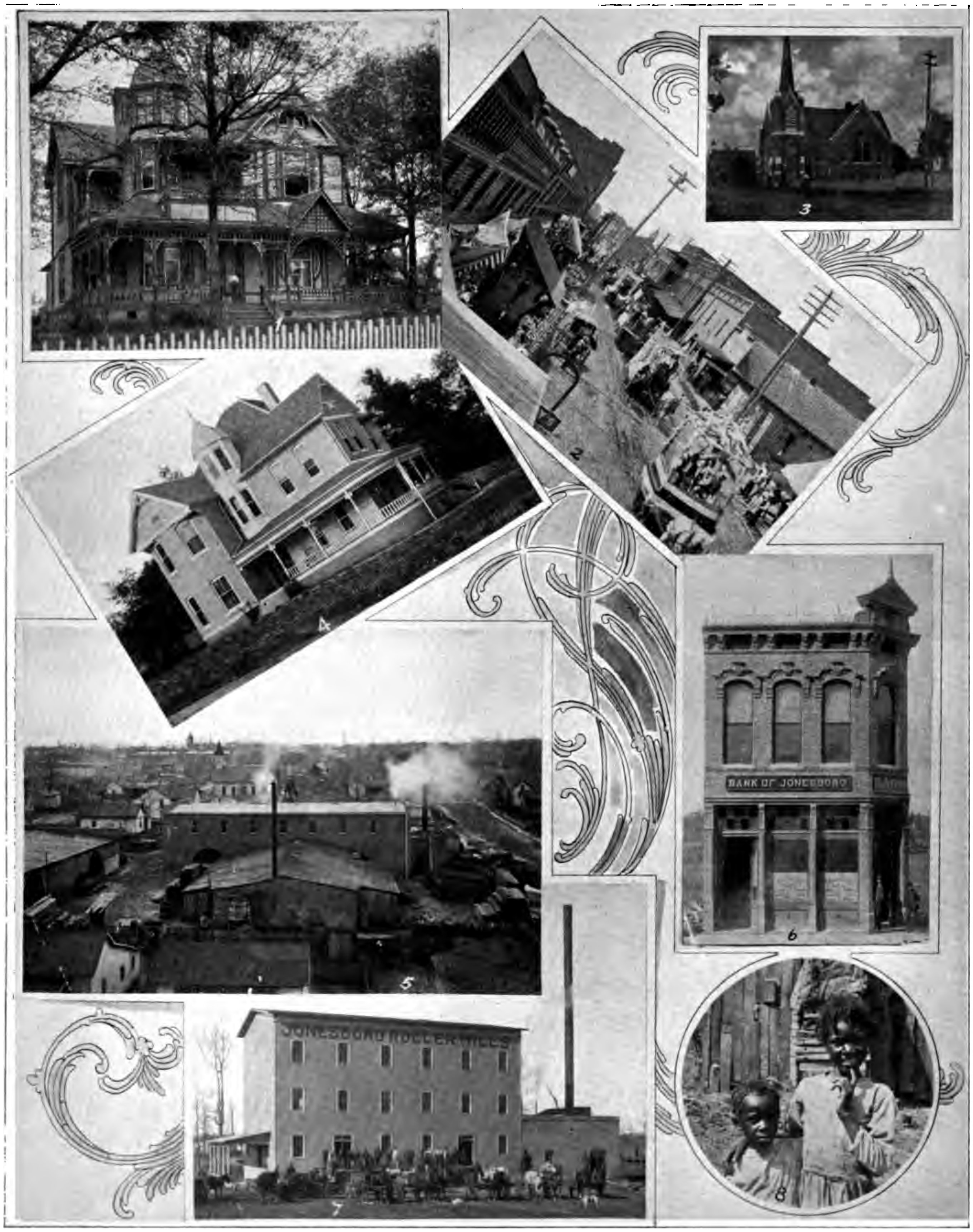


CRAIGHEAD COUNTY
ARKANSAS

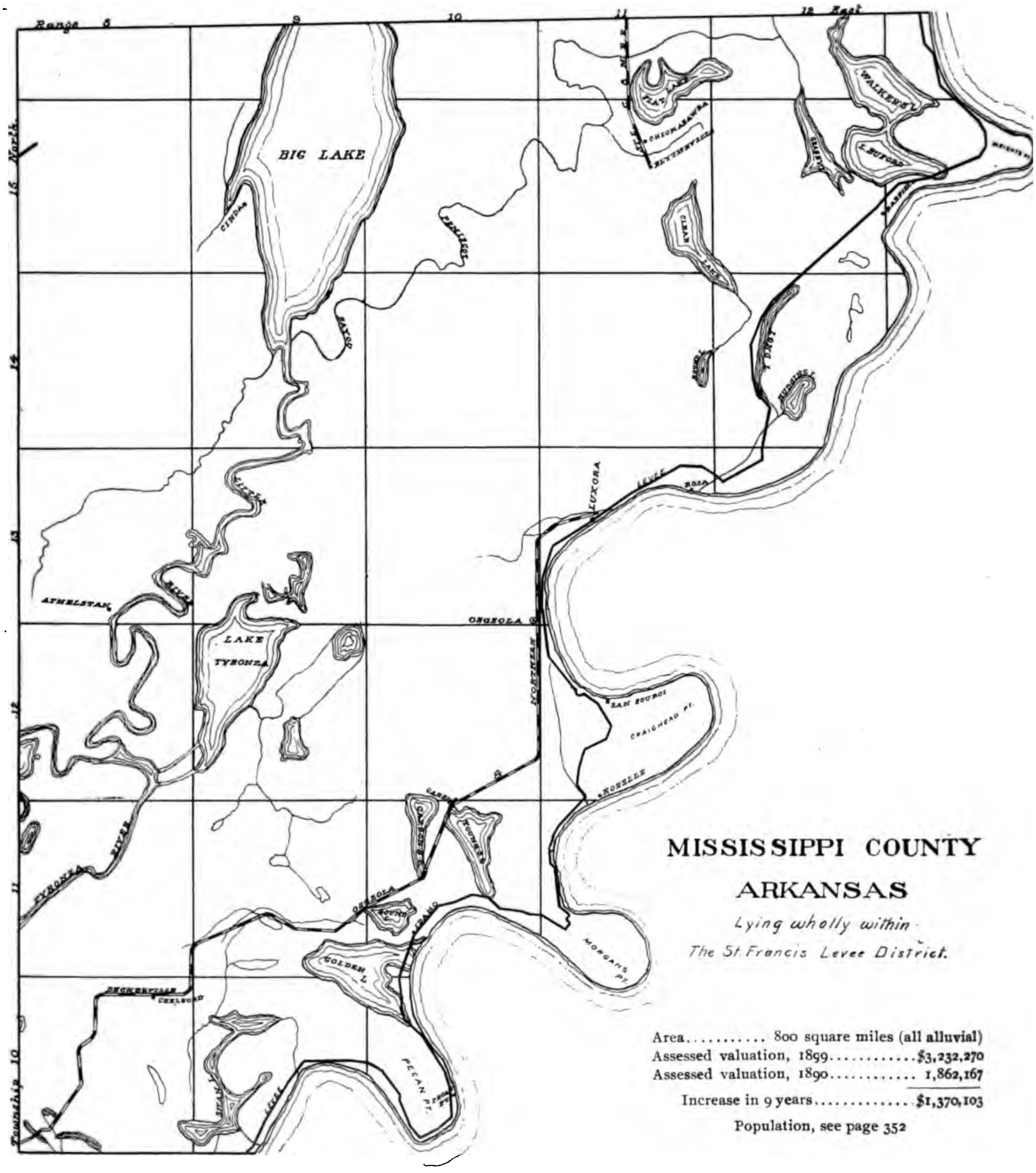
Lying partly within
The St Francis Levee District.

Area.........700 square miles (⅔ alluvial)
Assessed valuation, 1899.........$4,179,010
Assessed valuation, 1890......... 3,091,765

Increase in 9 years...........$1,087,245
Population, see page 352



VIEWS OF JONESBORO, ARKANSAS



MISSISSIPPI COUNTY

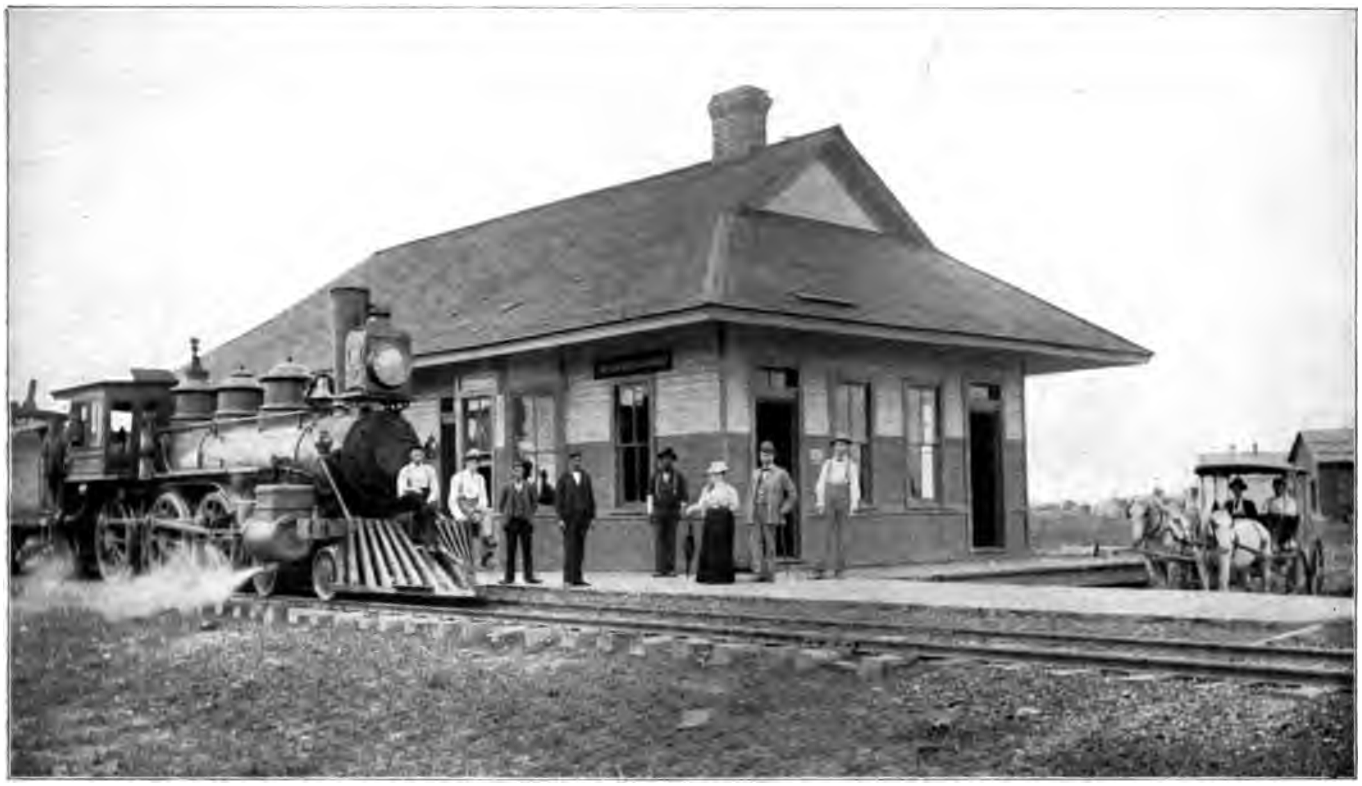
ARKANSAS

Lying wholly within

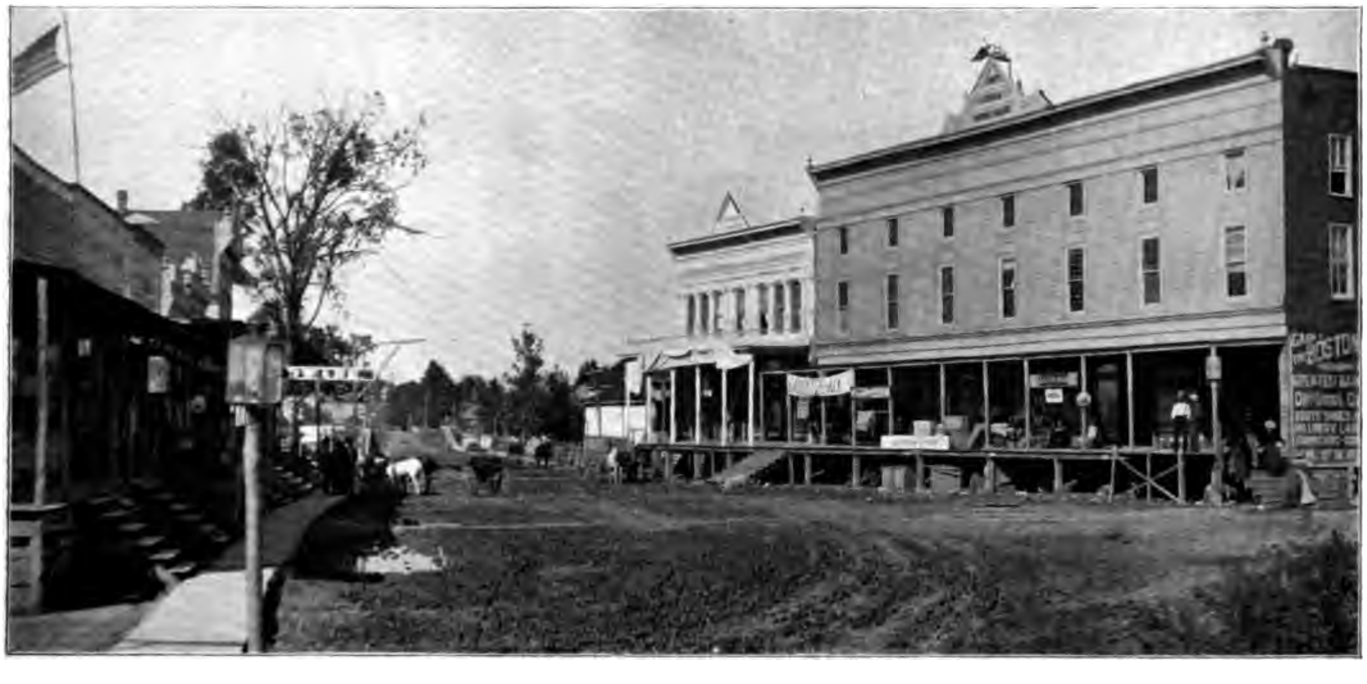
The St. Francis Levee District.

Area	800 square miles (all alluvial)
Assessed valuation, 1899	$3,232,270
Assessed valuation, 1890	1,862,167
Increase in 9 years	$1,370,103

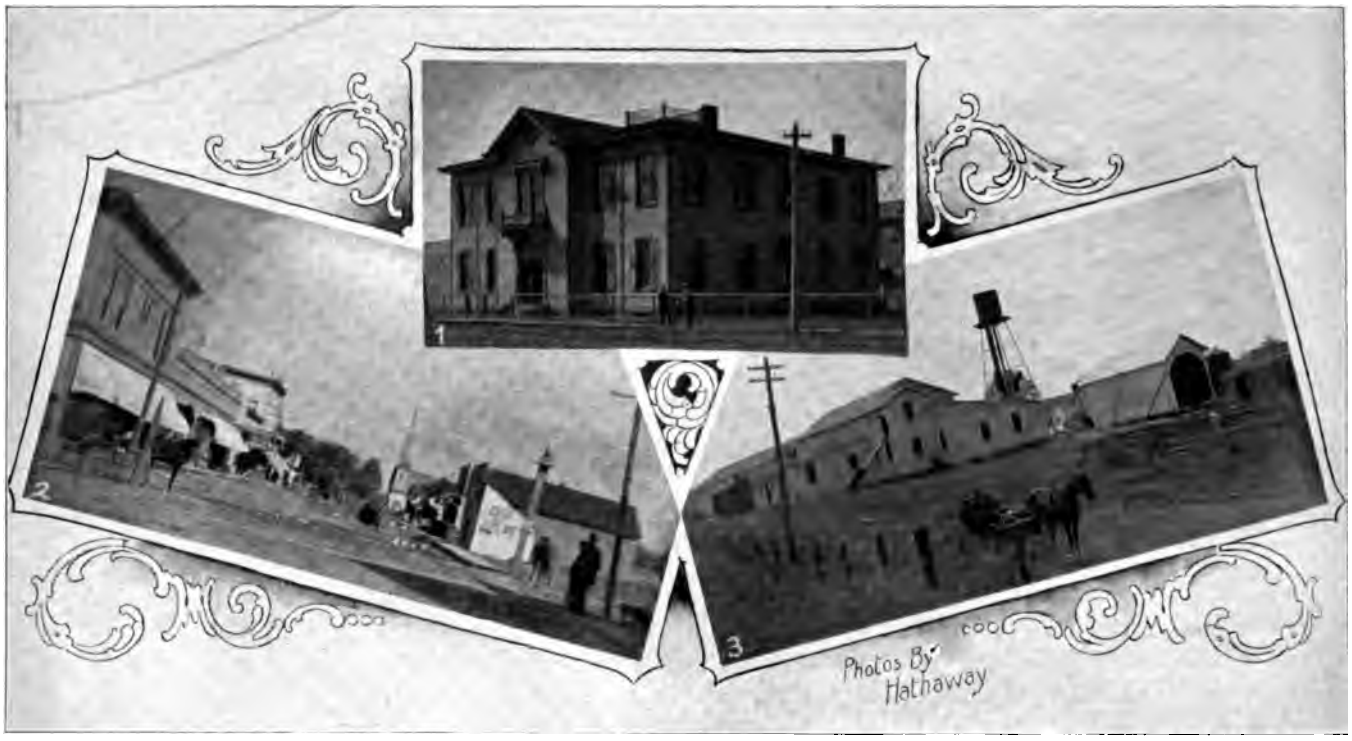
Population, see page 352



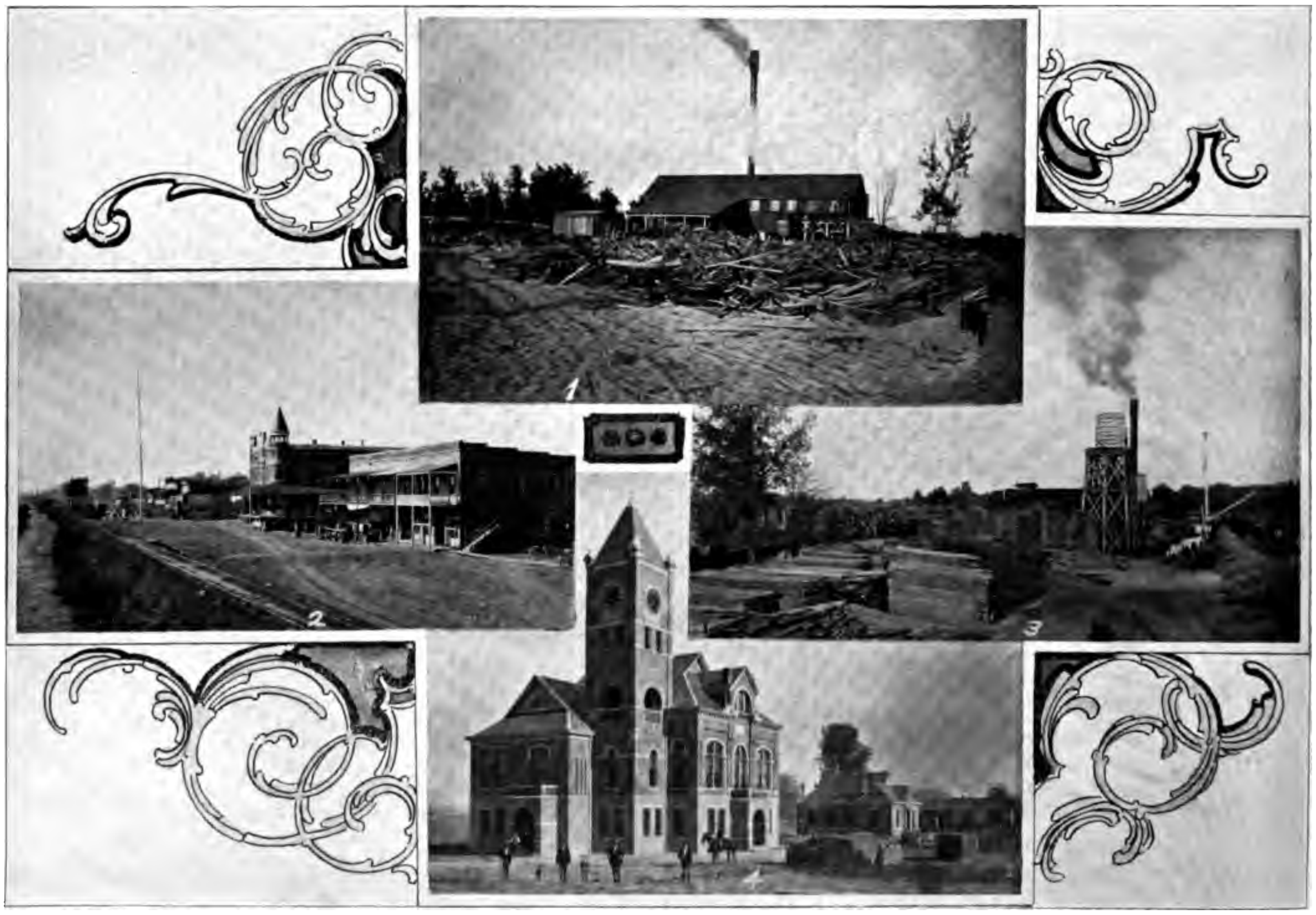
DEPOT OF THE DECKERVILLE, OSCEOLA & NORTHERN RAILROAD AT LUXORA, ARKANSAS



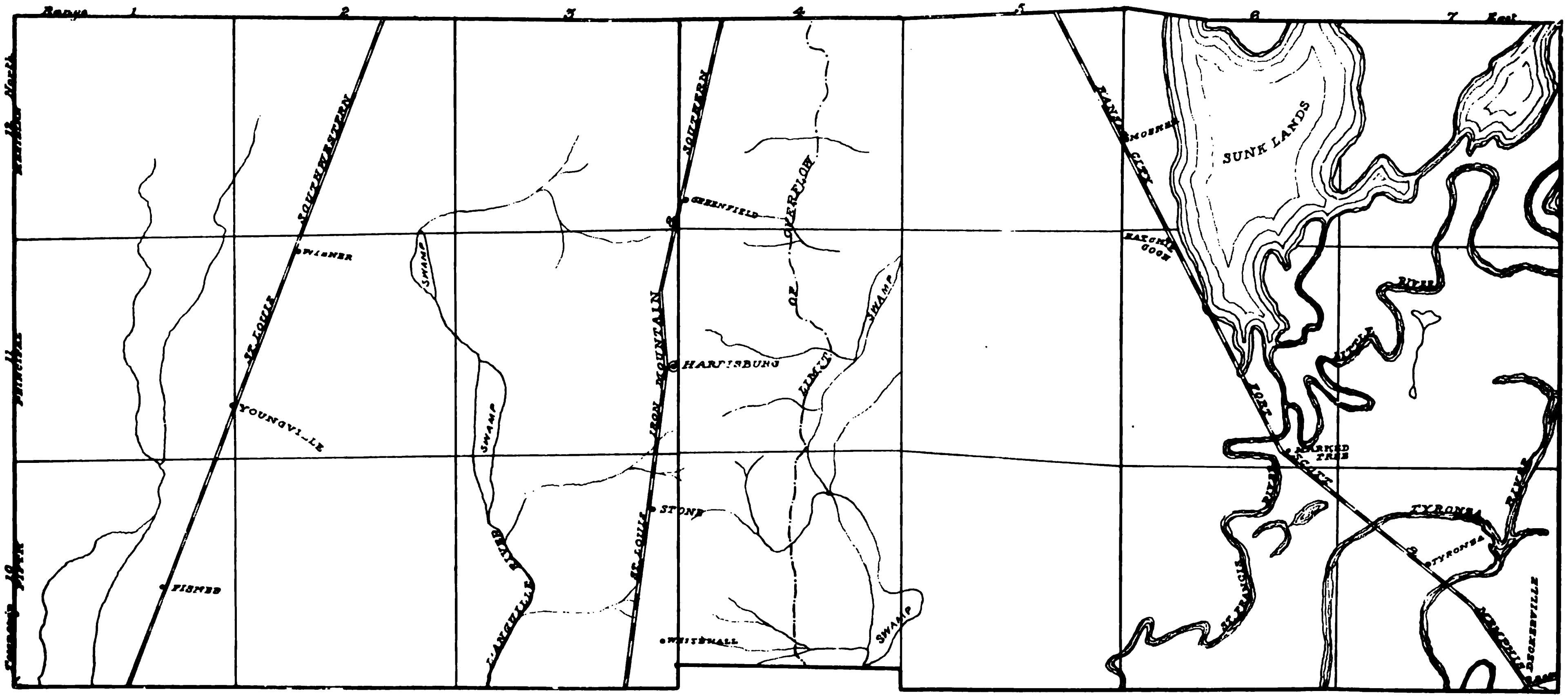
VIEW OF PRINCIPAL BUSINESS STREET, LUXORA, ARKANSAS



VIEWS OF OSCEOLA, ARKANSAS

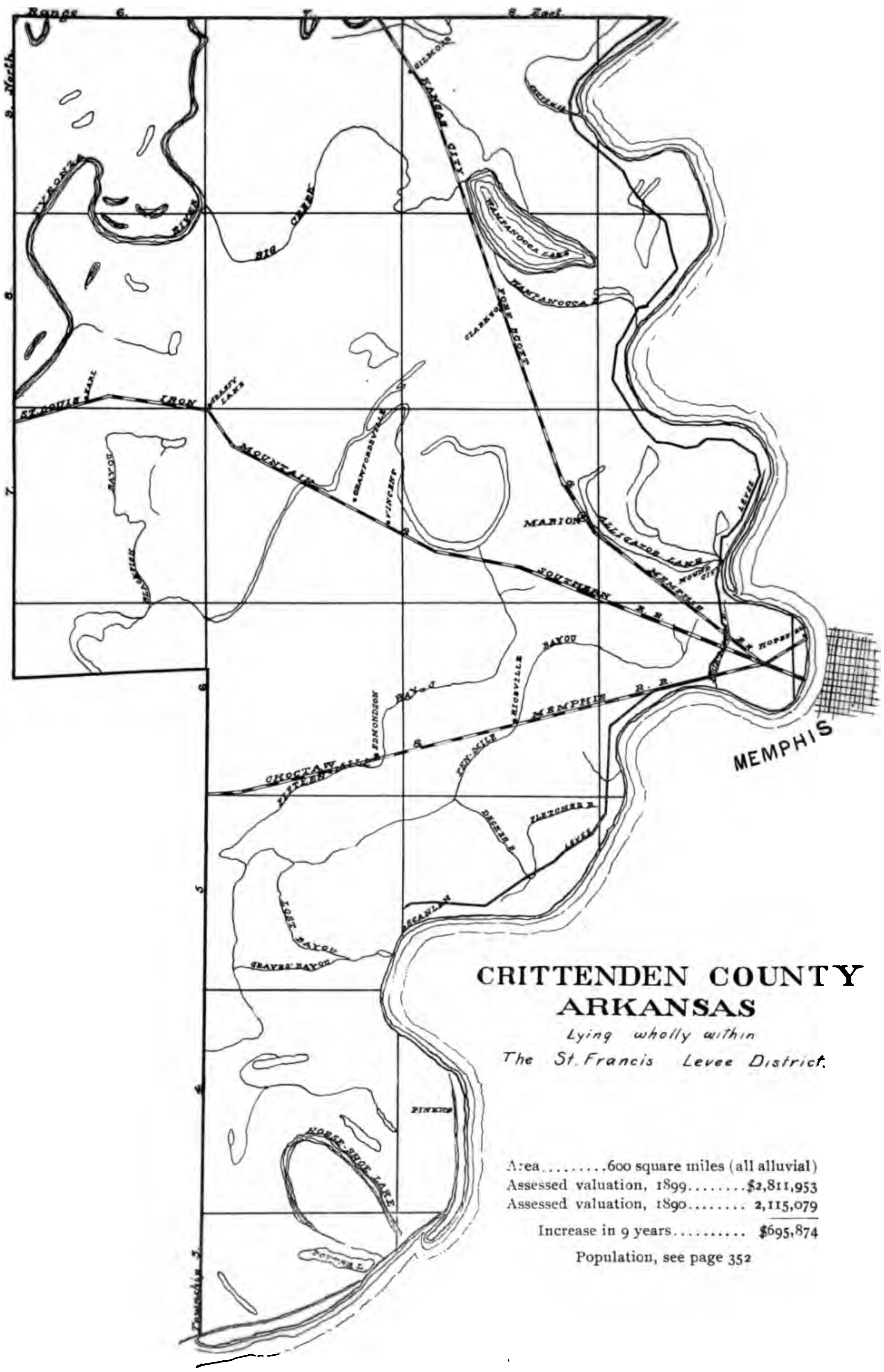


VIEWS OF ARKANSAS CITY, ARKANSAS



Area.........648 square miles (¾ alluvial)
Assessed valuation, 1899.........$1,990,327
Population, see page 352

POINSETT COUNTY
ARKANSAS
Lying partly within
The St Francis Levee District

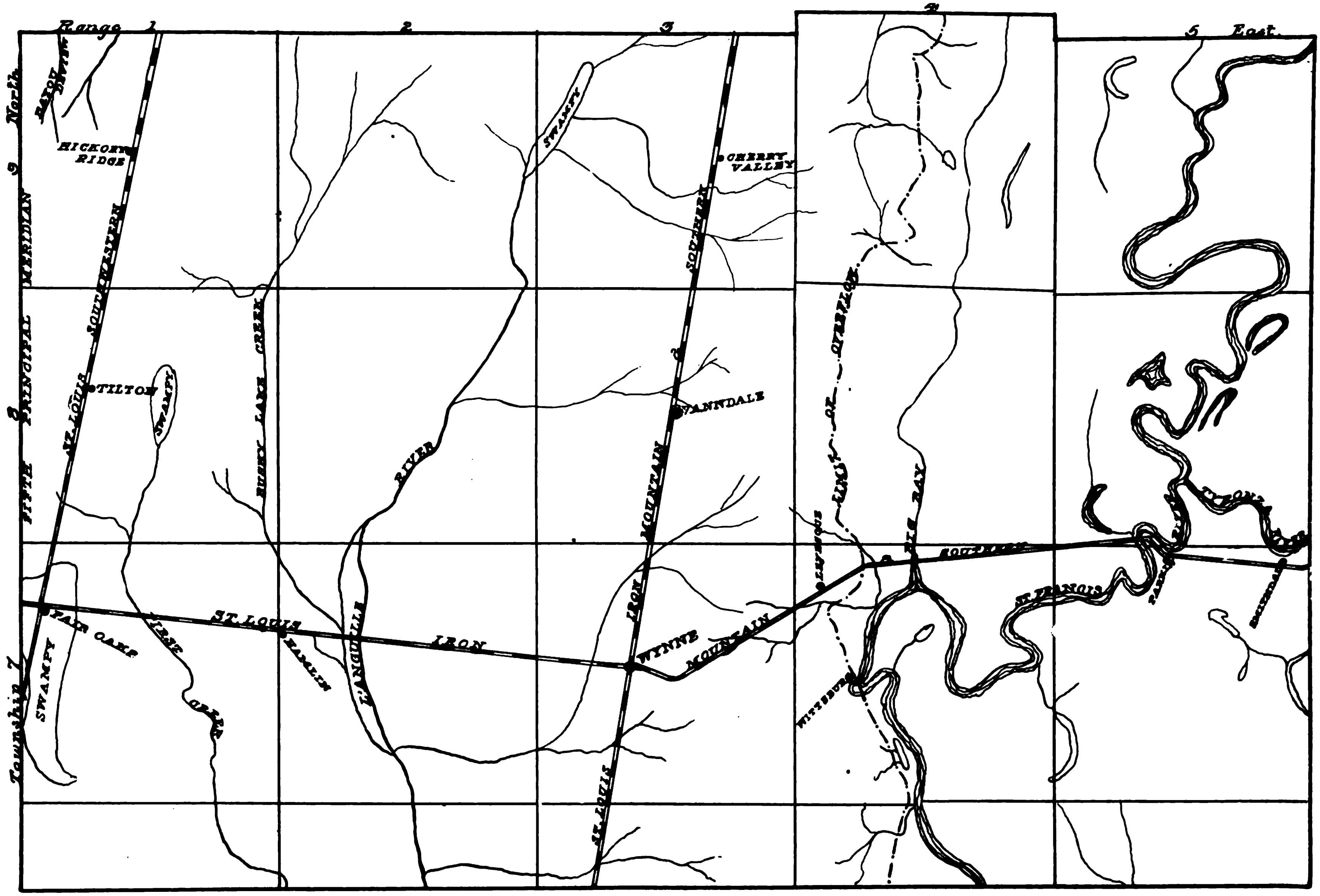


CRITTENDEN COUNTY
ARKANSAS

Lying wholly within
The St. Francis Levee District.

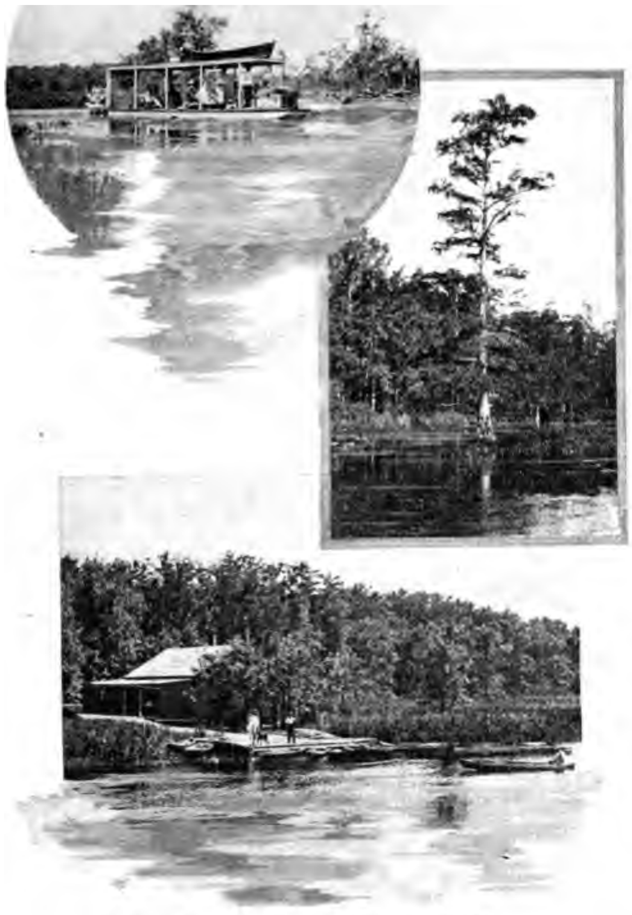
Area.........600 square miles (all alluvial)	
Assessed valuation, 1899........	$2,811,953
Assessed valuation, 1890........	2,115,079
Increase in 9 years..........	$695,874

Population, see page 352

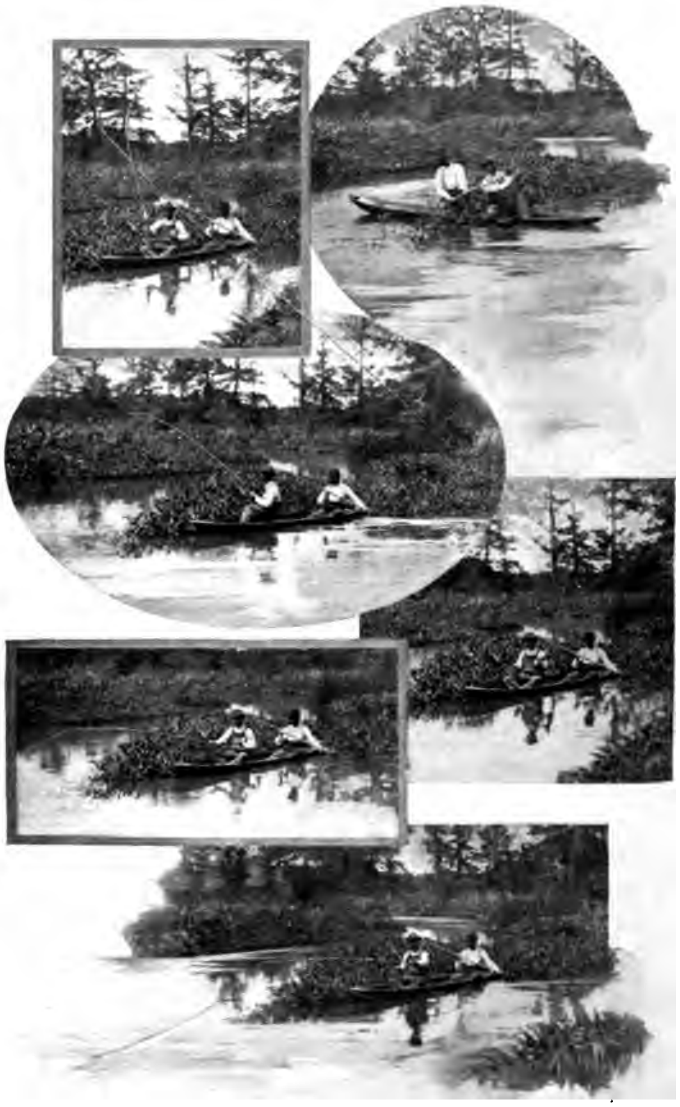


Area..........600 square miles (¾ alluvial)
Assessed valuation, 1899.........$2,330,350
Population, see page 352

CROSS COUNTY
ARKANSAS
Lying partly within
The St. Francis Levee District.



IN THE ALLUVIAL LANDS OF ARKANSAS

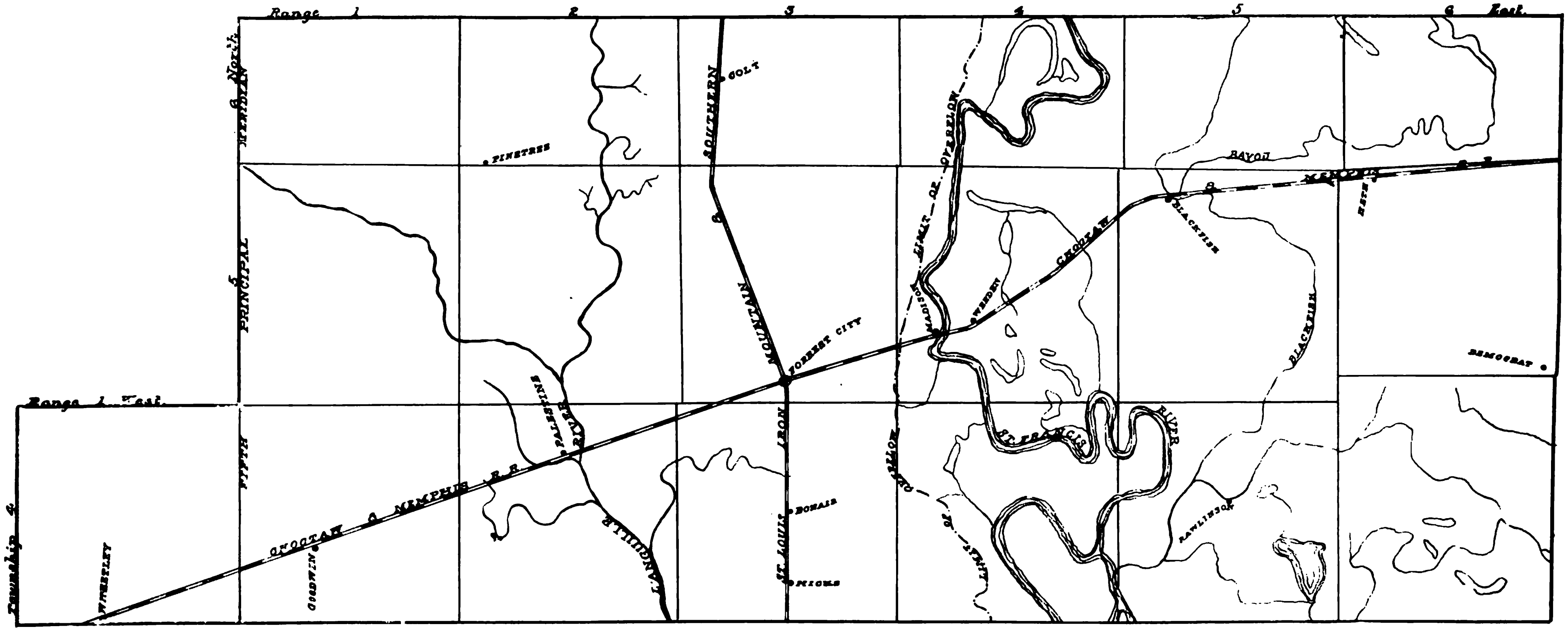


SCENES ON THE ST. FRANCIS
RIVER IN ARKANSAS

SCENES ON THE ST. FRANCIS RIVER IN ARKANSAS

DUCK HUNTING ON THE ST. FRANCIS RIVER

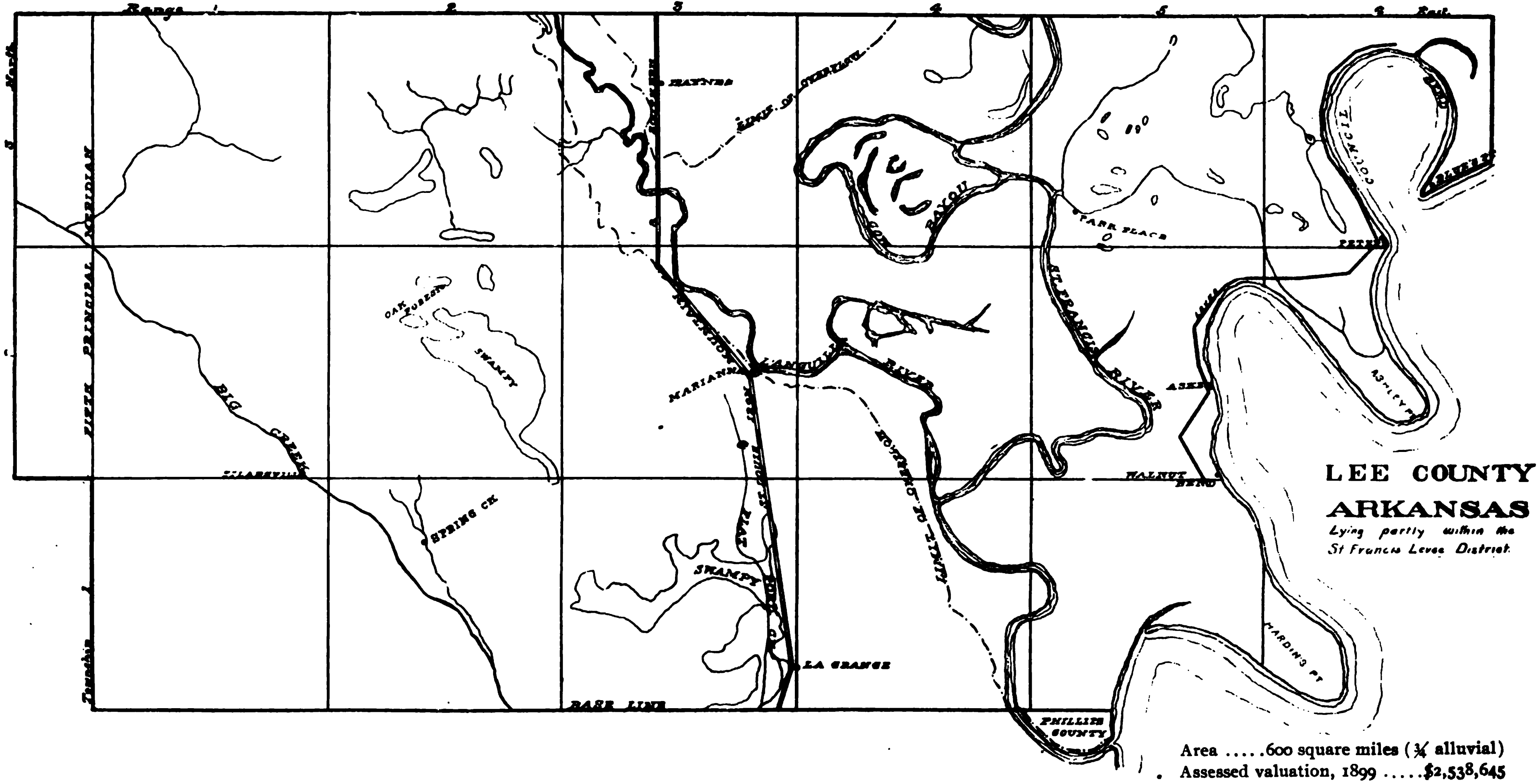
FISHING IN THE ST. FRANCIS RIVER



ST. FRANCIS COUNTY
ARKANSAS

Lying partly within
The St Francis Levee District

Area ....648 square miles (¾ alluvial)
Assessed valuation, 1899.........$2,645,586
Population, s e page 352



LEE COUNTY ARKANSAS

Lying partly within the St Francis Levee District.

Area .....600 square miles (¾ alluvial)
Assessed valuation, 1899 .....$2,538,645
Population, see Page 352

A "DUGOUT" AND BOATMAN ON THE ST. FRANCIS RIVER

TRAINING RETRIEVERS

SCENE ON THE UPPER ST. FRANCIS RIVER IN ARKANSAS

TROLLING ON THE ST. FRANCIS RIVER

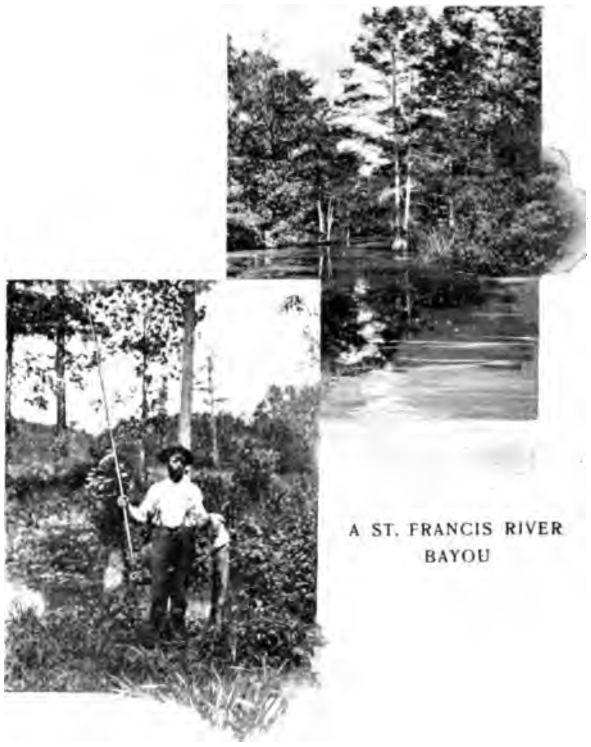
SCENE ON THE UPPER ST. FRANCIS RIVER IN ARKANSAS

NEAR LONE GUM TREE ISLAND, ST. FRANCIS RIVER

THE SPORTSMAN'S PARADISE—

FISHING CLUBS ON THE ST. FRANCIS RIVER

DUCK SHOOTING WITH A RETRIEVER



A ST. FRANCIS RIVER BAYOU

A FAIR SAMPLE

SCENES NEAR LAKE CITY, ARK.

SPEARING FROGS AT NIGHT

ALONG THE ST. FRANCIS RIVER IN ARKANSAS

systematically and on business lines, would prove very profitable in this section.

The increase in population for the entire state of Arkansas is 16.25 per cent., but the alluvial counties show a larger per cent. of increase than the average. Mississippi county, for instance, shows 40.82 per cent. increase; Craighead county 62.20 per cent., and Pulaski county, in which is situated Little Rock, and which is largely alluvial, 33.49 per cent.

The population is a home-loving, church-going, school-supporting people, and very kindly and sociable by nature.

There is yet considerable government lands subject to homestead entry; also, much state land subject to donation to actual settlers, and a great deal of railroad lands, belonging principally to the St. Louis, Iron Mountain & Southern Company, which are for sale.

The sawmills have invaded these sections for the last dozen years, and have cut many hundreds of millions feet of the fine timber which grows in such profusion; yet their work of demolition has been almost imperceptible. There are yet in the bottoms of Arkansas between the Missouri and the Louisiana borders, millions of acres of the finest hardwood timber land on the face of the globe. The principal growths are the gum, cottonwood, ash, poplar, white oak, walnut, and cypress. The manufacture of lumber consists in preparing it for shipment in the half-manufactured state, to other parts of the United States and to Europe. Barrel heads, staves and stave timber are sent in large quantities across the ocean. Lumber for all commercial purposes, some partially manufactured into box material, is shipped to nearly all parts of the United States. Indeed the timber supply of Arkansas has been so attractive, and so immense that it is largely responsible for the smaller systems of railways which are now reaching out through these sections, and as the sawmills become more and more numerous these railroads will keep pace, either in new roads, or in spurs and branches of the existing systems, and when this rich land shall have been denuded of its timber, the fertile farms will thus have ample railway facilities to ship their products to the markets of the United States, as well as the incomparable system of river navigation which they now have.

To write up all of these counties and their manifold attractions separately would require very much space, and would really be largely a repetition.

At the head of this article is given the names of the alluvial and semi-alluvial counties, with their population in 1880, 1890 and 1900. Maps accompanying this review show all of the existing lines of railroad, together with many projected branches, and give statistics of population and assessed valuation.

The development in the alluvial sections of Arkansas has brought into existence of recent years several thriving towns, and has increased to the dignity of cities many more which were but struggling villages or small towns before the levee system begun. For instance, Paragould, which was not given a separate mention in population of 1880, from a town of 1,606 inhabitants in 1890 is now rated as one of the most wideawake, enterprising and growing cities of northeast Arkansas. Jonesboro, which in 1880 had a very small population had, in 1890, increased to a little city of 2,065, and the late census gives it a total of 4,508. This shows an increase to two and a half times its size of ten years ago. It has all the characteristics and push, and the full complement of industrial enterprises that are usually found in a growing city. Situated on Crowley's Ridge, the alluvial sections on both sides, and in the midst of some of the finest timber lands in the Mississippi valley, its prosperity and growth have been natural and regular, and it bids fair to exceed in another decade the remarkable progress it has made in the last.

In Mississippi county we see on the banks of a river a very great improvement in the county seat, Osceola, and a new town with nearly 1,000 inhabitants, Luxora, a few miles north of Osceola, which does not appear in the census of 1890. It has in the past five or six years sprung into existence, and become a thriving and growing town.

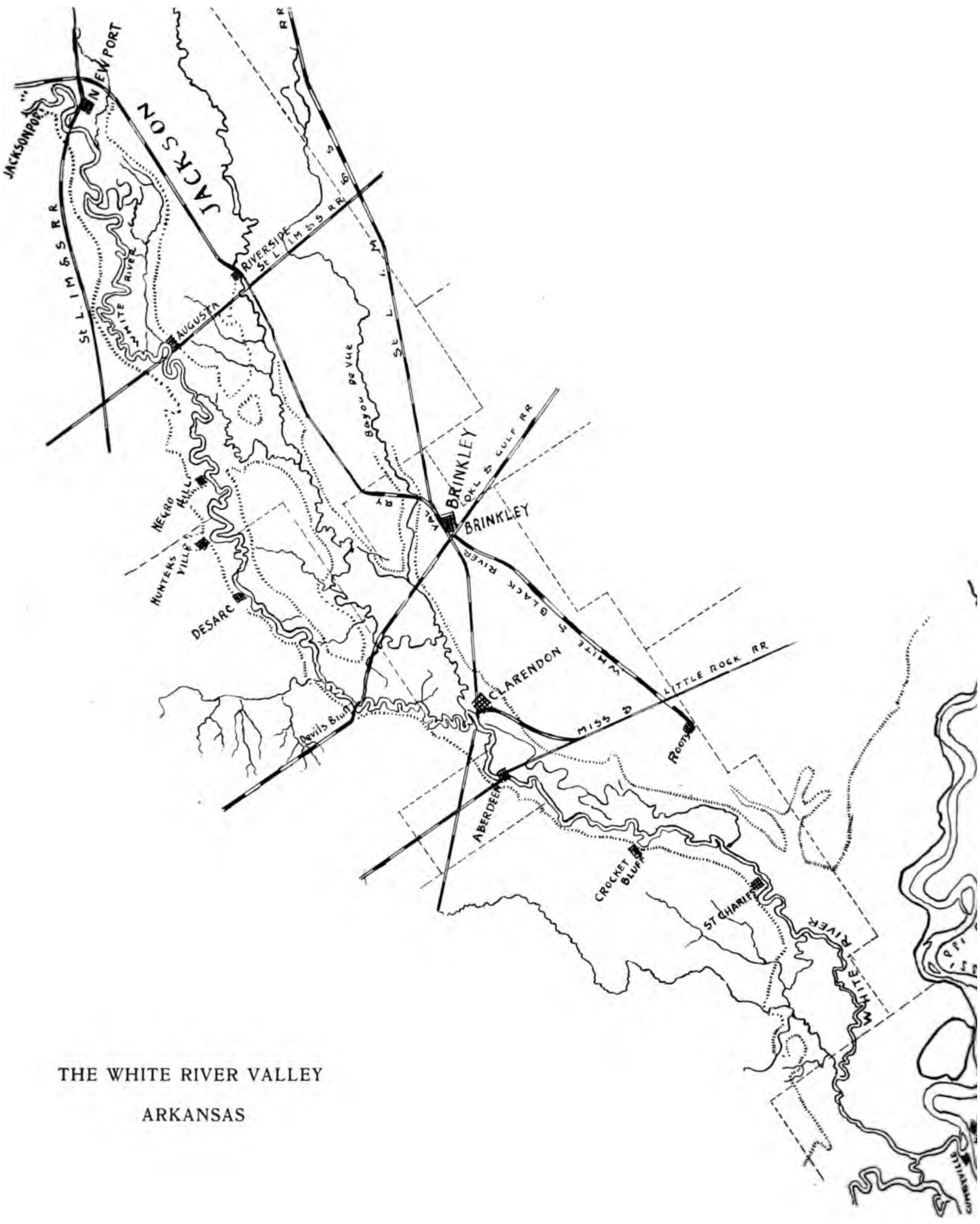
Wynne, in Cross county, with its sawmills and other industrial enterprises, has grown up as if by magic.

Forrest City, Marianna, the latter on the Helena branch of the Missouri Pacific, the former also on this branch, and on the Choctaw, Oklahoma & Gulf railway, are rapidly growing towns. Marianna holds the record for the shipment of lumber and timber. It is near the St. Francis River, and sawmills are cutting away the fine virgin timber, and shipping it to all parts of the United States, and across the ocean.

Other towns bordering the alluvial sections which are partaking of the impetus following

LAKE CHICOT, IN CHICOT COUNTY, ARK.

COUNTY COURT HOUSE BUILDING, NEWPORT, ARK.



THE WHITE RIVER VALLEY

ARKANSAS

THE FERRY ACROSS WHITE RIVER, NEWPORT, ARK.

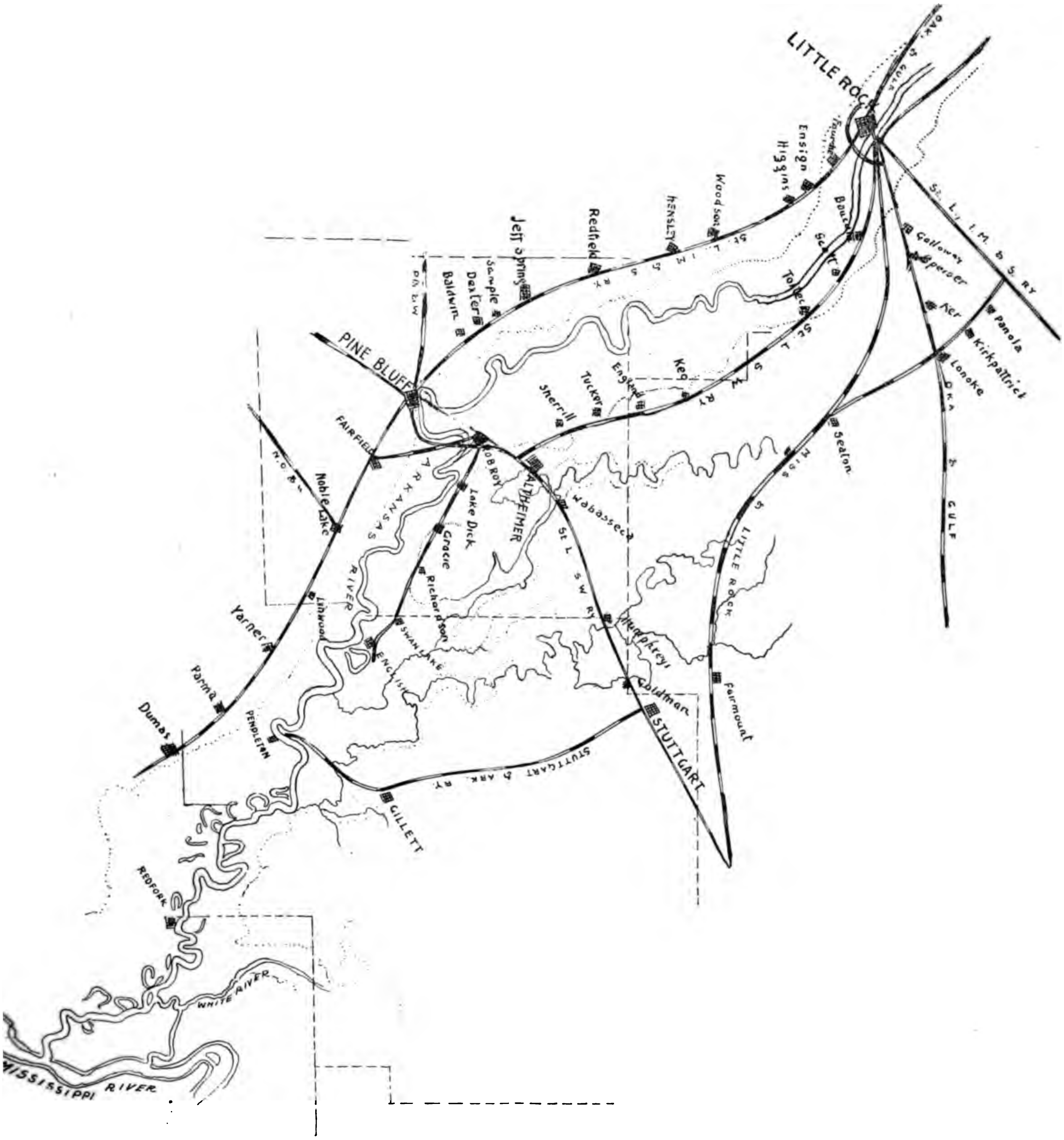
WHITE RIVER, NEWPORT, ARK.

SCENES ALONG THE BEAUTIFUL WHITE RIVER

the introduction of sawmills and the opening up of the rich lands are Marktree, Deckersville, Arkansas City, Lake City, Monette, Leachville, Blytheville, Tyranza, Harrisburg, Vanndale, Nettleton, Lake Village, Marion, and others specially shown on the outline maps of the Arkansas and White River valleys.

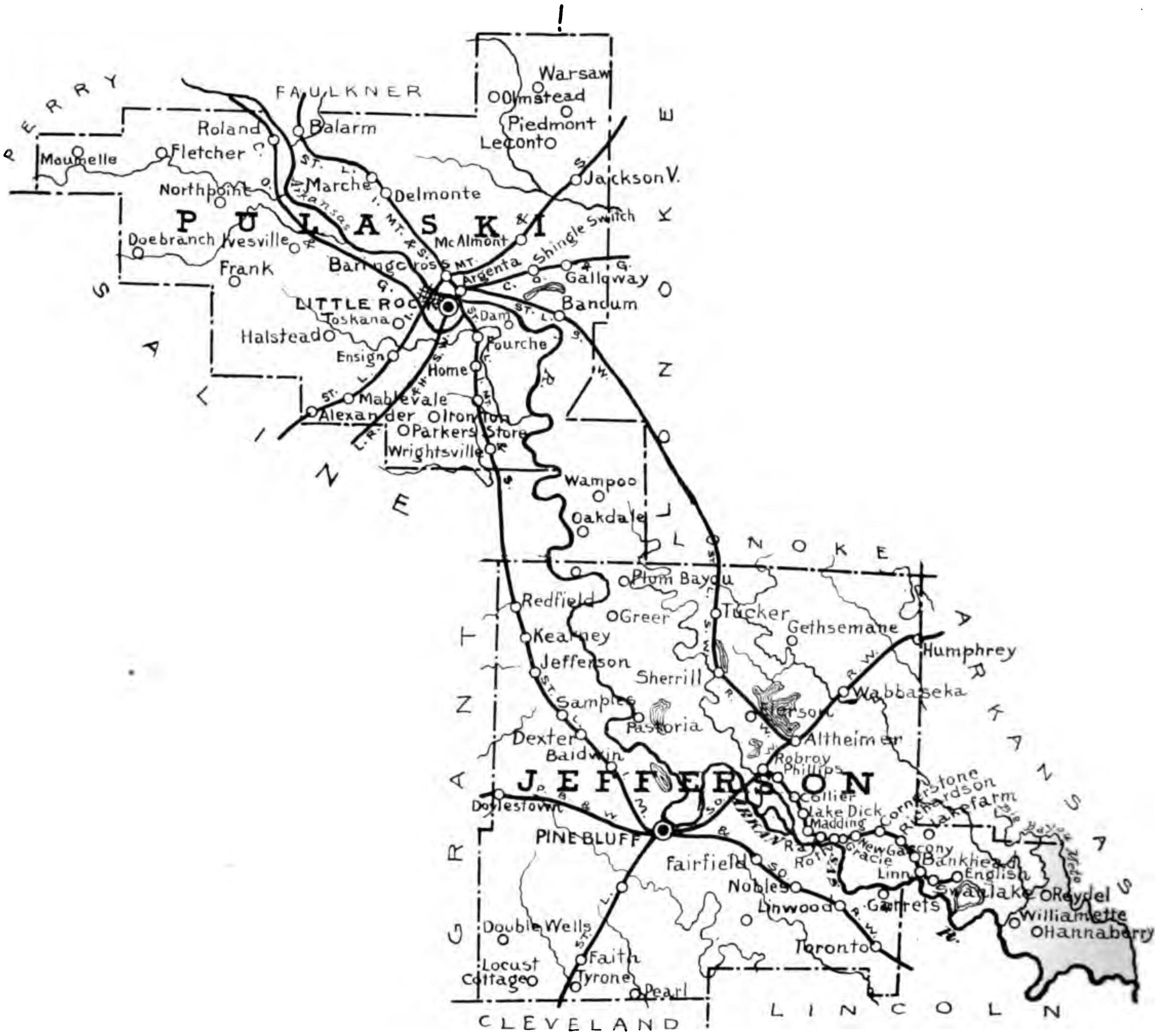
In the latter pages of this book will be found a list of real estate agents and others, who will take pleasure in answering any inquiry regarding these favored and fertile sections, and the State Bureau of Immigration and Agriculture at Little Rock will be glad to furnish full information to all who desire it.

PASTURE SCENE NEAR PARAGOULD, GREENE COUNTY, ARKANSAS



THE VALLEY OF THE ARKANSAS RIVER

(Showing North to Little Rock.)



JEFFERSON AND PULASKI COUNTIES, ARKANSAS

(Scale Reduced.)

For Population, see page 352.

LOGGING IN THE ALLUVIAL LANDS OF THE MISSISSIPPI RIVER

COTTON PLANTATION IN THE ARKANSAS RIVER VALLEY

COTTON PICKING IN THE ARKANSAS VALLEY, ARKANSAS.

"A HAPPY LITTLE ARKANSAS NIGGER."

SCENES IN THE ARKANSAS RIVER VALLEY

COTTON SCENE ON ARKANSAS RIVER, ARKANSAS.

"AN OLD-TIME PLANTATION NIGGER," ARKANSAS.

SCENES IN THE ARKANSAS RIVER VALLEY.

W. B. ALEXANDER

Mayor of Pine Bluff, Arkansas.

GEORGE R. BROWN

Secretary Little Rock Board of Trade.

FRED FOX

President Pine Bluff Commercial League.

E. D. RUSSELL

Secretary Pine Bluff Commercial League.

PINE BLUFF, ARKANSAS

Pine Bluff is the capital of Jefferson, the banner cotton-producing county of the world, as attested by the World's Fair first premiums and awards for long and short staple cotton. The city is located on the south bank of the Arkansas River, at the head of low-water navigation. A line of steamers ply between Pine Bluff and Memphis, giving healthful competition.

Four railroads enter Pine Bluff, namely: The Missouri Pacific, the St. Louis-Southwestern, the Pine Bluff-Arkansas River, and the Pine Bluff & Western. The two former are trunk lines, which, through their connections, give easy access to all parts of the United States. The two latter are short lines, extending through the great agricultural and timber sections of the county. All have unexcelled depot and terminal facilities within the corporate limits of the city.

The main shops of the St. Louis Southwestern Railway Co., the largest industrial plant in the South, are located at Pine Bluff. Among the other industries may be mentioned four large saw and planing mills, with combined daily capacity of 700,000 feet of lumber, two extensive cotton-oil mills, two modern cotton compresses, large foundry and machine shops, a splendid system of water works, gas and electric-lighting plants, the largest ice factory and cold storage plant south of St. Louis, two stave mills, and many other manufactories, too numerous for special mention here.

The citizens of Pine Bluff enjoy the inestimable benefits of a splendid system of sewerage, which has done much to reduce the already low mortality rate. The health of the city is fully attested by the fact that in 1898, of the 2,500 children enrolled in the public schools, not a single death occurred.

Pine Bluff has two splendid systems of telephone, namely: The Pine Bluff Telephone Co., and the Southwestern Telegraph and Telephone Co. The former is owned and operated by local parties, and, in addition to its city exchange, operates a long-distance line, reaching many points in Jefferson and adjoining counties. The latter, in addition to its local exchange, extends its lines to more than fifty towns and cities within the State, and affords direct communication with St. Louis, Memphis, Chicago and New York.

The Postal Telegraph-Cable Co., and the Western Union Telegraph Co. serve this point, which is a guaranty that the facilities for telegraphing are unsurpassed by those of any city in the world.

Pine Bluff has four solid and conservative banks to assist her business men, when necessary, in the conduct of their large industrial and commercial undertakings. The aggregate capital stock of the four amounts to $400,000, with deposits, as shown by their last quarterly statements, approximating $1,750,000.

The jobbing trade of Pine Bluff has kept pace with her increasing importance in other respects. The competition among the wholesale merchants is lively and capital ample, which attracts to this market many of the largest buyers in south Arkansas and north Louisiana.

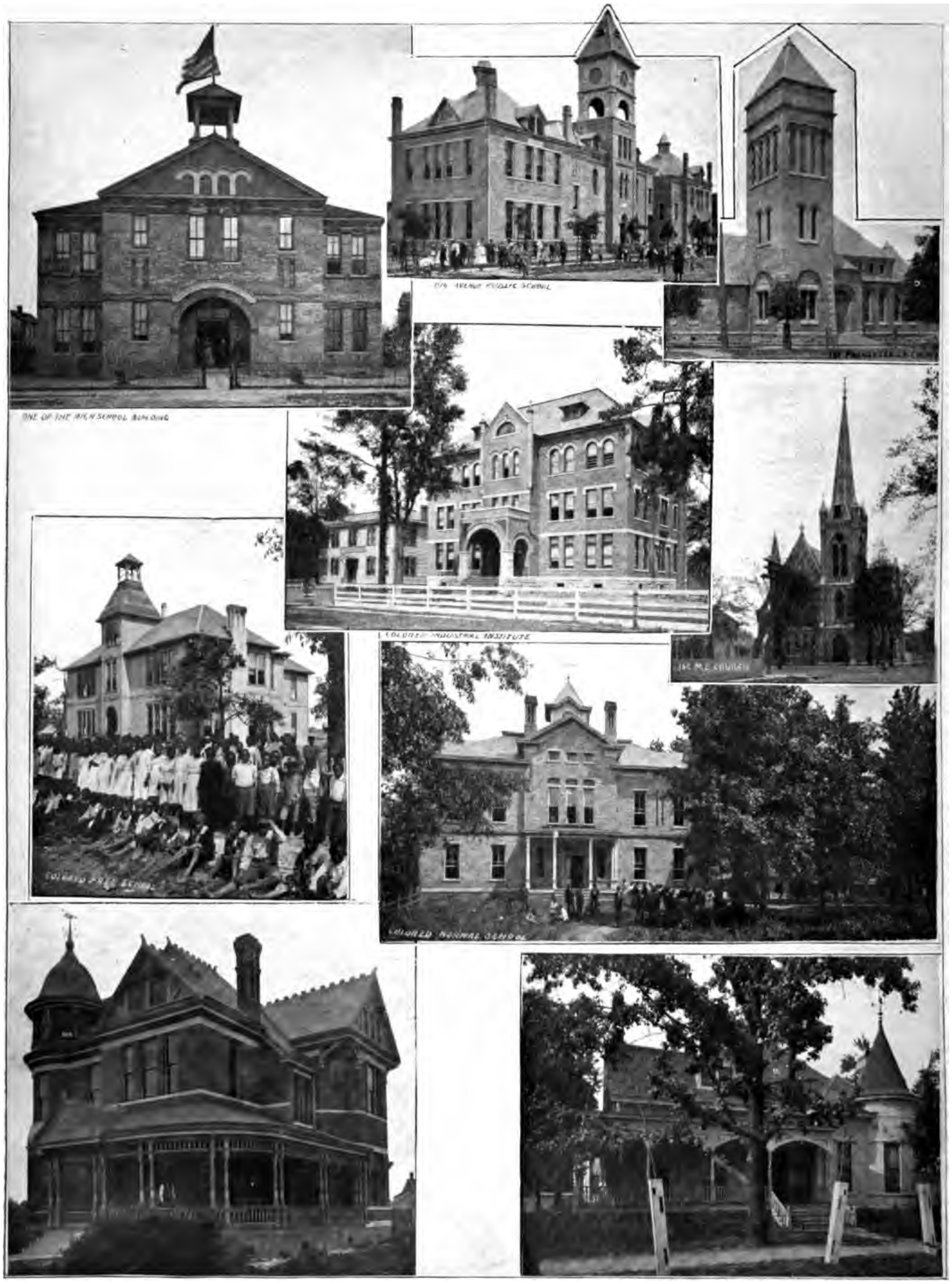
The annual cotton receipts amount to 100,000 bales, and the city has the largest incoming and outgoing tonnage of any city in the State. The wholesale mercantile houses do an annual business of $15,000,000.

If the saying that the retail trade of a city or town is the pulse to its commercial character be true, then Pine Bluff holds first place among the cities of the South.

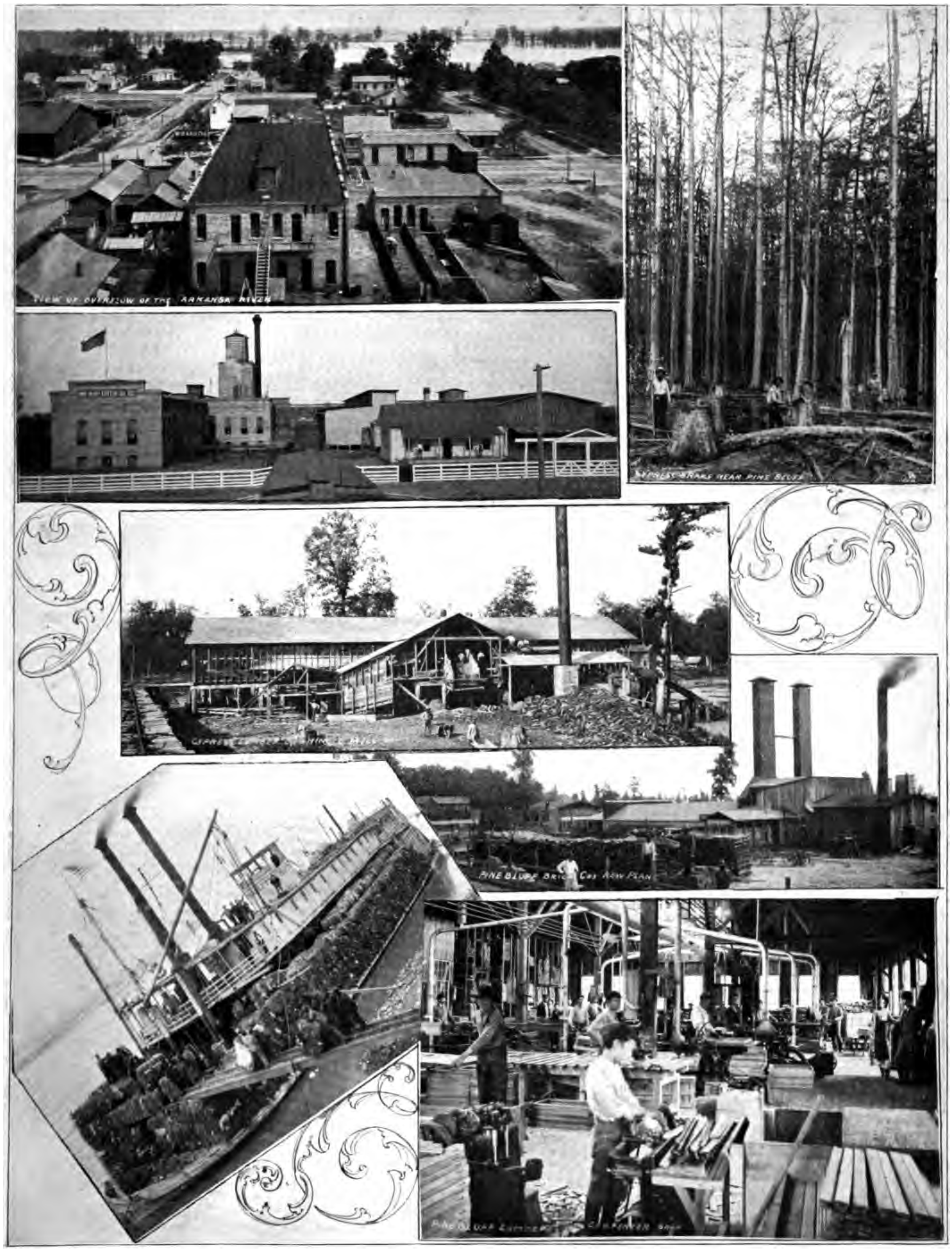
The citizens engaged in the retail trade are among the most intelligent and progressive, and the benefits they enjoy by reason of the large payrolls of the various manufacturing plants, make them ever ready to encourage and give substantial assistance to prospective investors in any industrial line.

Under the able direction of Mayor Alexander, assisted by the City Council and a Board of Public Affairs, composed of some of the most successful business men of the city, a comprehensive and intelligent system of public improvements has been inaugurated, and the city's debt reduced to practically nothing.

The City Fire Department, under experienced and intelligent management, has done much for



VIEWS OF PINE BLUFF, ARKANSAS


VIEW OF OVERFLOW OF THE ARKANSA RIVER
CYPRESS BRAKE NEAR PINE BLUFF
PINE BLUFF BRICK CO'S NEW PLANT

VIEWS OF PINE BLUFF, ARKANSAS

the preservation of property and the reduction of insurance rates in recent years.

There are four prosperous and ably edited newspapers in Pine Bluff, which labor for the advancement of every enterprise and interest touching the general progress and prosperity of the city and State.

The hotel accommodations of Pine Bluff are ample and first-class.

The rate of taxation for State, county and municipal purposes is twenty-two and one-half mills on the dollar.

Pine Bluff is a city of churches, as well as schools and commerce, and her citizens are noted for the pride they take in their religious, as well as their educational and commercial institutions. Almost all denominations are represented within her corporate limits, and many of them have magnificent and stately church edifices.

No city in the United States has better public or private schools than Pine Bluff. Of the Public School buildings, eight in number, seven are substantially built of brick and stone.

Annunciation Academy, which is a Catholic school, under the management of the Sisters of Charity, is first-class in every respect. The Colored Industrial Institute, under Catholic auspices, and the Richard Allen Institute, under Presbyterian auspices, are doing much to educate, enlighten and elevate the colored youth of Jefferson and surrounding counties. The Branch Normal College, the negro department of the University of Arkansas, was established at Pine Bluff in 1883 by act of the Legislature, and is the leading colored educational institution of the State.

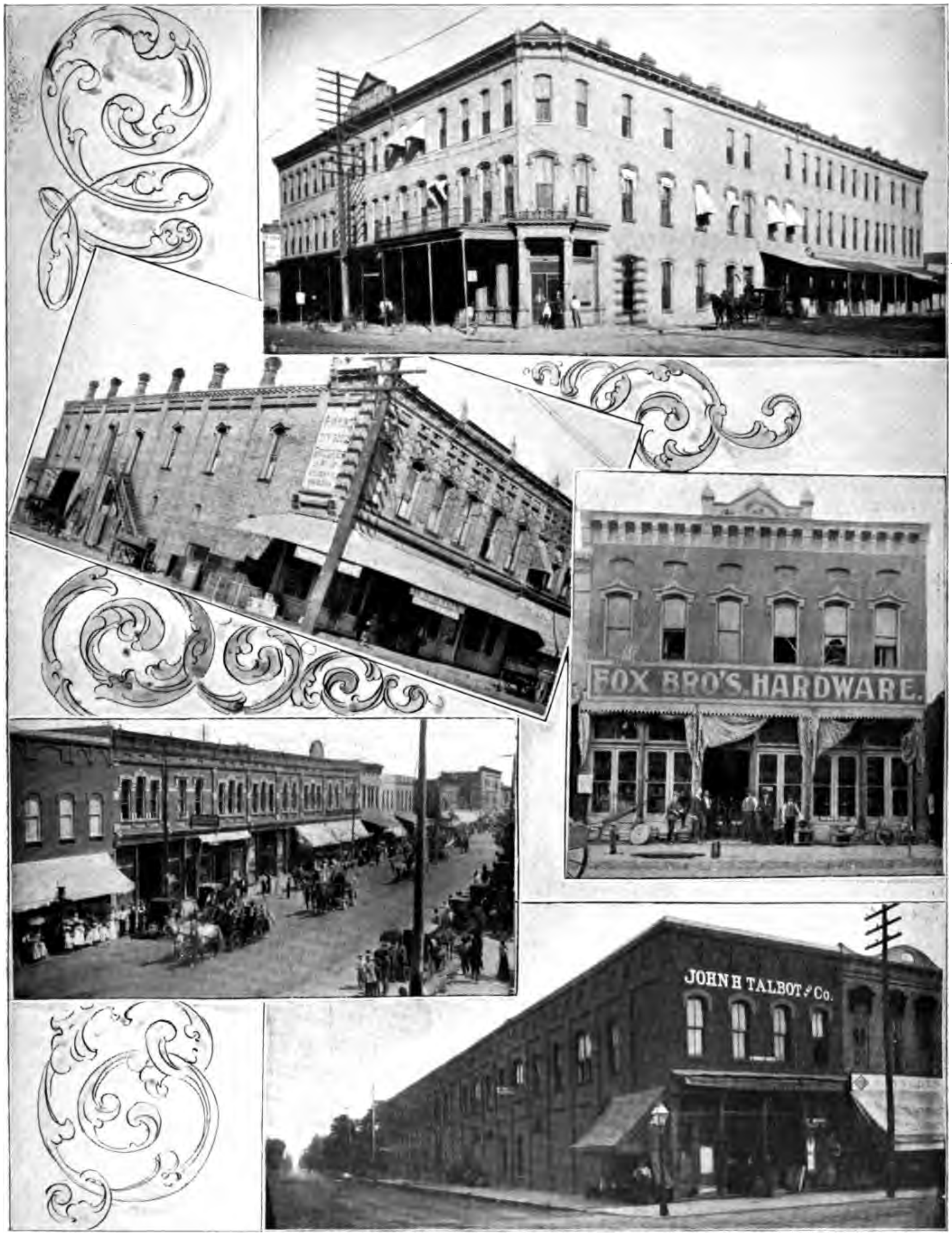
While the federal census for 1900 gives the city only 11,496 inhabitants, it is conservatively estimated that at least 1,000 persons living within the corporate limits of the city were overlooked by the enumerators. This is due largely to the fact that at the time the enumerators were compiling their reports, many of the people were out of the city on summer vacation. Besides this, the suburbs of Mechanicsville, Greenville, Battleville, Hoboken and Lakeside, have an aggregate population of 7,000, and contribute to the commercial and industrial importance of the city proper. This is an increase of about 8,000 souls in the past decade.

The Pine Bluff State Fair Association holds at Pine Bluff in October of each year, and is largely attended by citizens from other sections of the State. The exhibits at these annual meetings bear unimpeachable evidence of the great natural resources of this section.

Among the improvements contemplated in the near future are: An electric street railway, opera house, cotton factory, furniture factory and pulp and paper mill.

The citizens of Pine Bluff are ever ready to encourage any enterprise in the way of manufacturing industries or public improvements calculated to redound to the ultimate benefit of their city and county. The Commercial League of Pine Bluff, of which Mr. Fred Fox is the President, and Mr. E. D. Russell is the Secretary, and having for its object the advancement of the commercial and industrial interests of the city and county, the inculcation of just and equitable principles of trade and the establishment and maintenance of uniformity in the commercial usages of the city, earnestly desires the consideration of the home-seeker, developer and capitalist, knowing that the city and county present unexcelled opportunities for acquiring desirable homes and the profitable employment of energy, capital and enterprise. The arms of the officers and members of the Commercial League, as well as those of every other citizen of Pine Bluff and Jefferson County, are ever wide open for the reception of desirable immigration, and such as come among them to live or invest their capital to profitably develop the unsurpassed resources of the city or county will receive a most cordial welcome. The civilization is refined and property secure—so much so as in any State in the Union.

Persons desiring special information relative to Pine Bluff or Jefferson County, should address the Secretary of the Commercial League, Pine Bluff, Arkansas.



STREET SCENES AND GENERAL VIEWS OF PINE BLUFF, ARKANSAS

LITTLE ROCK, ARK.

Little Rock is situated near the center of the State of Arkansas and is 287 feet above tide-water. Ten years ago it had a population of 25,874. The recently announced report of the census bureau gives it 38,307, a gain of 48.05 per cent for the decade. This does not include the population of that part of the city on the north side of the river known as Baring Cross, which has a distinct municipal government.

The bank clearings and the cotton receipts are well in line with the increase in population, both running about fifty per cent. In real-estate the aggregate business is about $150,000 a month. During the last eighteen months, according to report of the R. G. Dun Mercantile Agency, the increase of the number of new commercial enterprises has averaged one for each day, including Sundays and holidays.

BIRD'S-EYE VI

The enrollment at the public school at this time is 3,269 whites, 2,028 colored, a gain from last year of 211 whites and 30 colored. The total church membership is 11,300.

During the past two years the transportation facilities of the city have been increased by the extension of the Choctaw, Oklahoma & Gulf Railway and the building of the Little Rock and Hot Springs Western Railway, affording a total of eight railroad outlets. The Arkansas River is navigable to this point nearly the year around.

The railroads are the St. Louis, Iron Mountain & Southern, north, south and east. The Little Rock & Ft. Smith, the Pine Bluff & New Orleans, and the St. Louis Southwestern. The aggregate freight traffic for the year ending August 31, 1900, was 67,320 car loads, exceeding the traffic of the year before by 6,137.

The area of the city is 11.45 square miles, with 225 miles open streets, of which 55 miles are improved. The streets around 12 city blocks are paved with granite; around 35 with brick; around 59 with Telford macadam, and around 612 with gravel. The sewer system of the city has a total length of 22 miles.

The Arkansas River is spanned by four magnificent bridges at this point, three of which are owned by the railroads, and one jointly by the city and county. The last-named has been recently built at a cost of $377,257.63, and saves to the people of the city and county annually over $80,000 in tolls. There are now 1,156 business houses in the city, three compresses, ten banks, one cotton mill, four cottonseed oil mills, twenty-seven newspapers and periodicals, two telephone systems, four lighting companies, a paid fire department, and a comprehensive electric street-railway system.

The aggregate number of industrial plants is 157 and the number is steadily increasing.

The bonded indebtedness is only $118,000, and the floating debt $35,000, and the rate of taxation is low. The aggregate commerce of the city last year was about $20,000,000, and it is estimated by conservative business men that the total this year will be increased by at least $10,000,000 more.

Little Rock is not only the chief city of the State in size and in commercial importance, but it is also the political and social center and the site of all the State institutions except the University. It is located in the richest cotton lands of the State, and at the same time its western suburbs reach to the foothills of the Ozark Mountains. The country to the west is hilly, mountainous, heavily wooded and abounds in minerals. That to the east is level, alluvial, without rock and susceptible of a high state of cultivation. In fact, the first rock west of the Mississippi River is found here, and it was from this rock that the city was named by the French when the settlement was known as "petite Roche." The rock in question is now used as a pier for one of the railroad bridges.

The entire Arkansas Valley may well be considered as tributary to Little Rock. The territory tributary to the Arkansas River may be divided as follows:

Agricultural lands, 2,573,632 acres; timber and mineral lands, 2,342,834 acres.

LITTLE ROCK, ARKANSAS

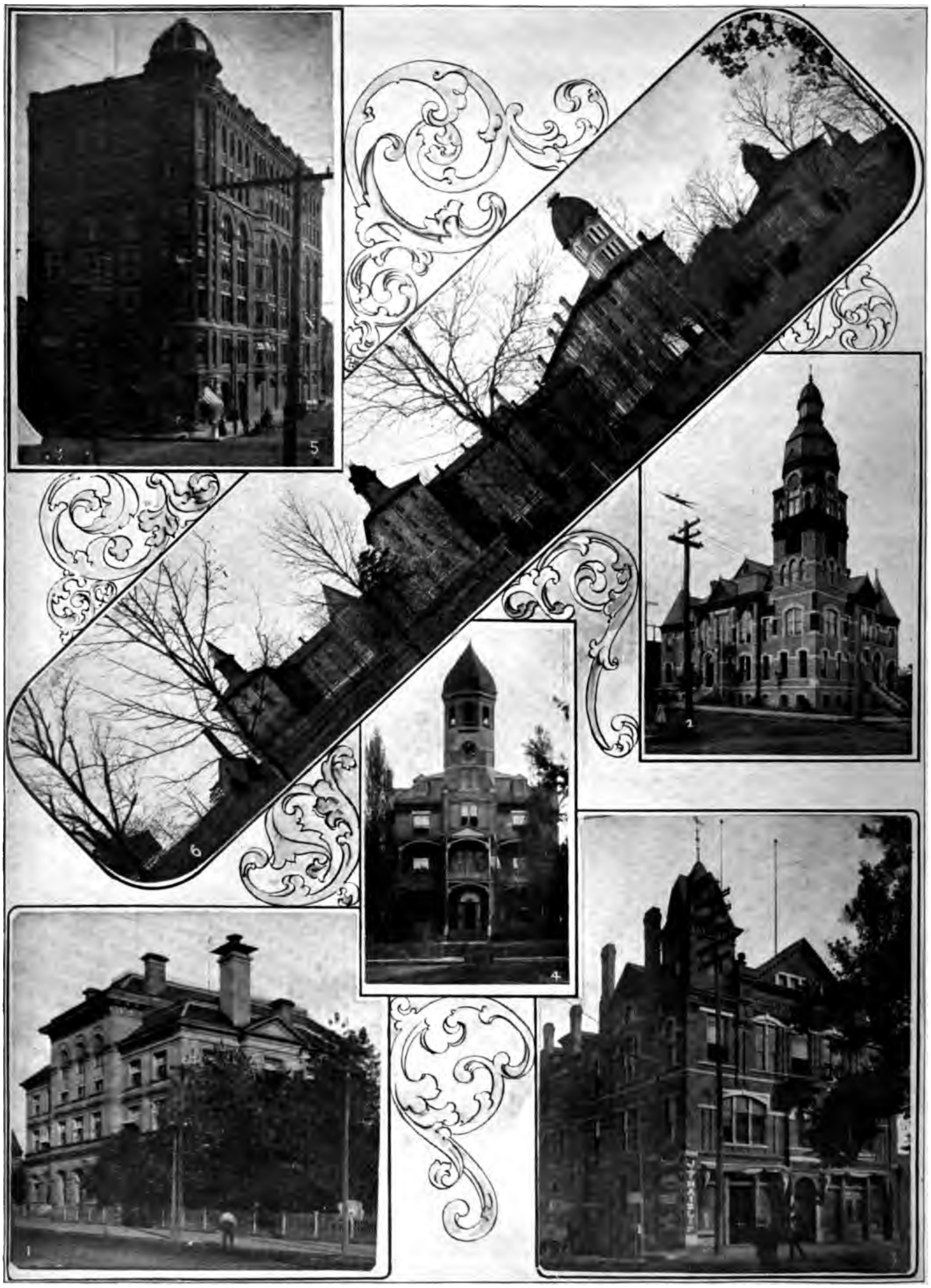
When the Government rises to the importance of improving its rivers, this vast area will make wonderful progress. In fact, even at the present time, no part of the country is growing more rapidly than Little Rock and adjacent cities and counties.

The situation of Little Rock is particularly advantageous. To the west of the city are coal mines, to the south bauxite, to the north zinc and marble and on all sides are great fields of cotton, grain, and some of the finest orchards in the United States.

In the undeveloped alluvial districts between it and the Mississippi River, as well as in the mountainous sections to the north and west, and in the river bottoms along the Arkansas and White Rivers, are seemingly inexhaustible acres of magnificent timber of all descriptions. It is hardly necessary to dilate further on the business energy of the city, since the fact stands out by its increase in population.

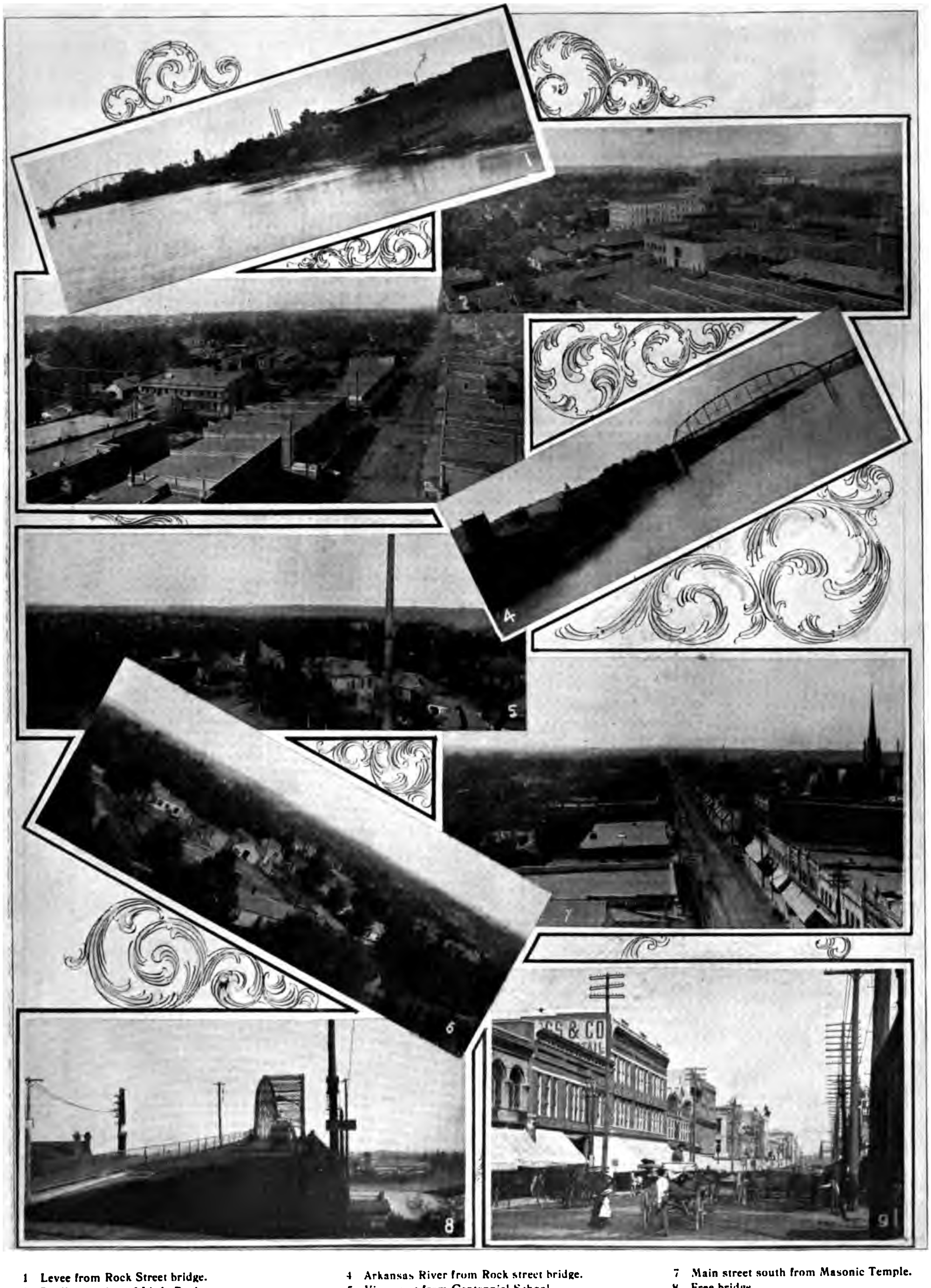
A city of progress, of good morals, of schools, of churches, of factories, and of general commercial and industrial activity, it affords opportunity alike for the investor, the active business man and the home-seeker. Little Rock is not content with even a nearly 50 per cent. growth in a decade, for, with a full appreciation of the wonderful surroundings, the undeveloped millions of timber and agricultural lands, she has placed her figures for a full 100 per cent. for the next census, and is working steadily for it.

* * *



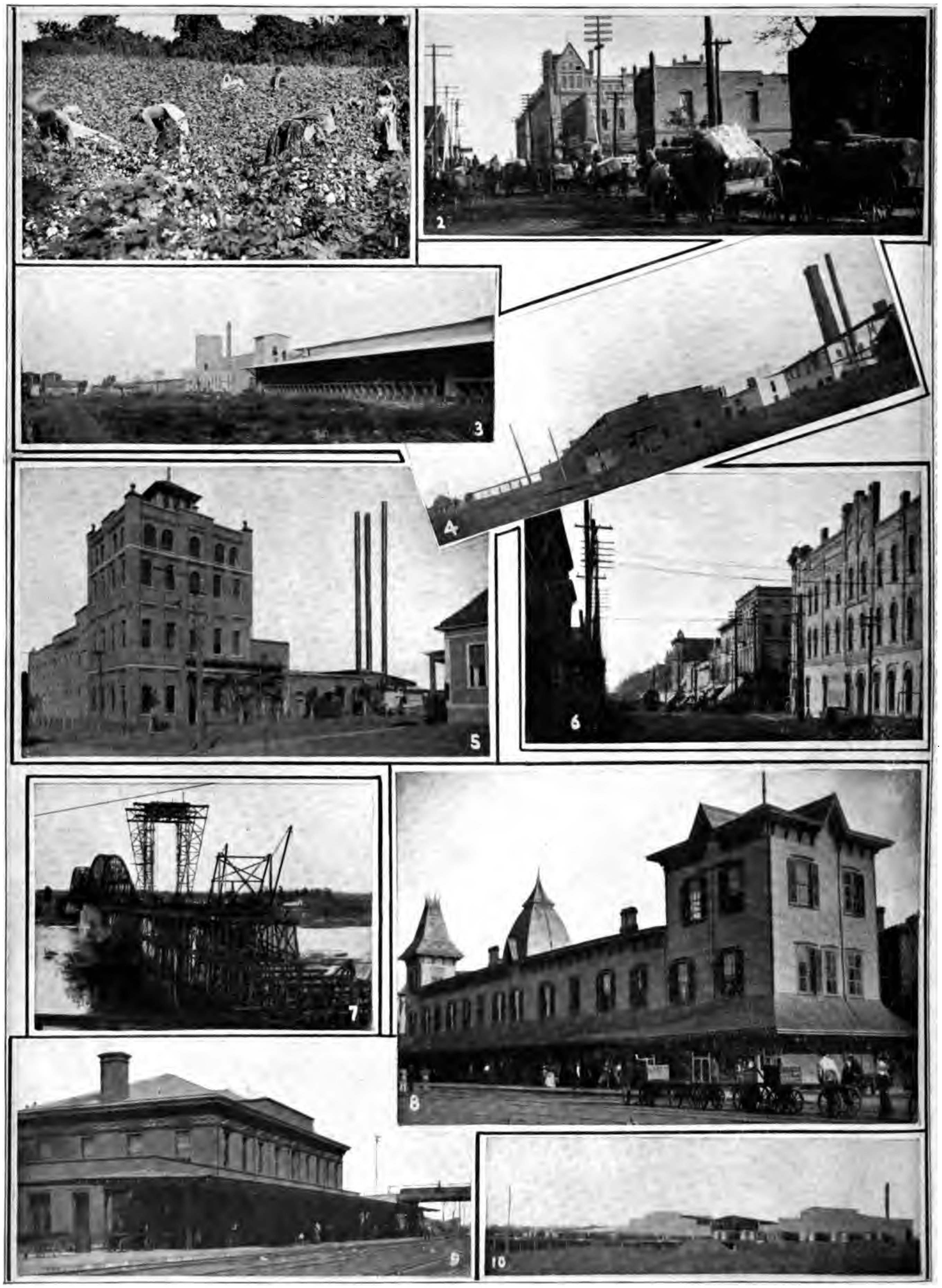
1 United States court house and postoffice.
2 Pulaski County court house.
3 Board of Trade building.
4 One of the buildings of the Arkansas School for the Blind.
5 Masonic Temple.
6 Arkansas State Lunatic Asylum.

VIEWS OF LITTLE ROCK, ARKANSAS



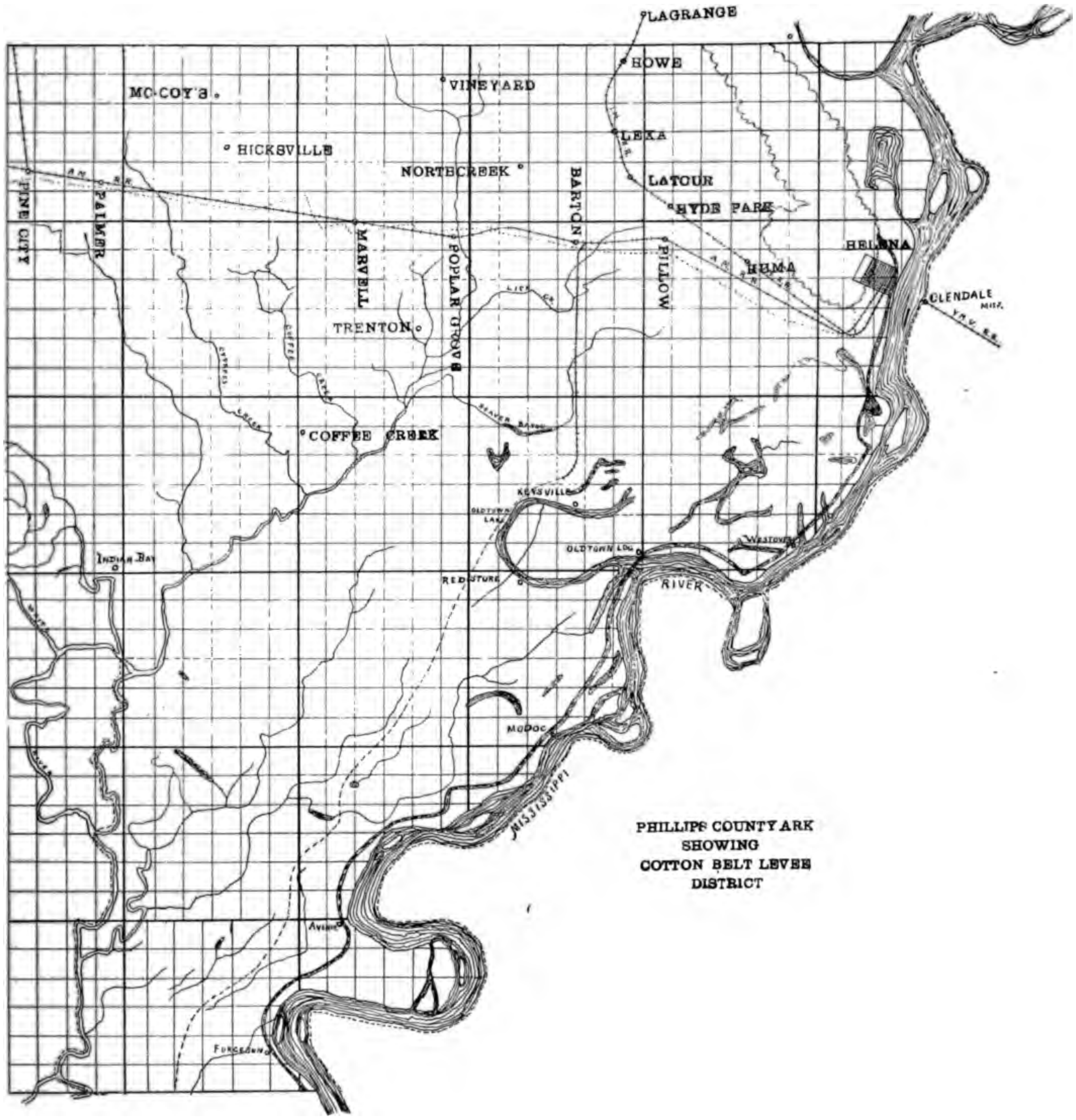
1 Levee from Rock Street bridge.
2 Bird's-eye view of Little Rock.
3 Fifth street east from Masonic Temple.
4 Arkansas River from Rock street bridge.
5 View west from Centennial School.
6 View east from Centennial School.
7 Main street south from Masonic Temple.
8 Free bridge.
9 Main street from Fourth street south.

VIEWS OF LITTLE ROCK, ARK.



1 Packing cotton near Little Rock. 3 Southern cotton oil mill. 5 Little Rock Brewery.
2 Cotton market at the Board of Trade. 4 Consumers' cotton oil mill. 6 Main Street south from Fourth Street.
7 Railroad bridge in course of construction. 9 Choctaw depot.
8 Union depot. 10 Union compress.

VIEWS OF LITTLE ROCK, ARKANSAS



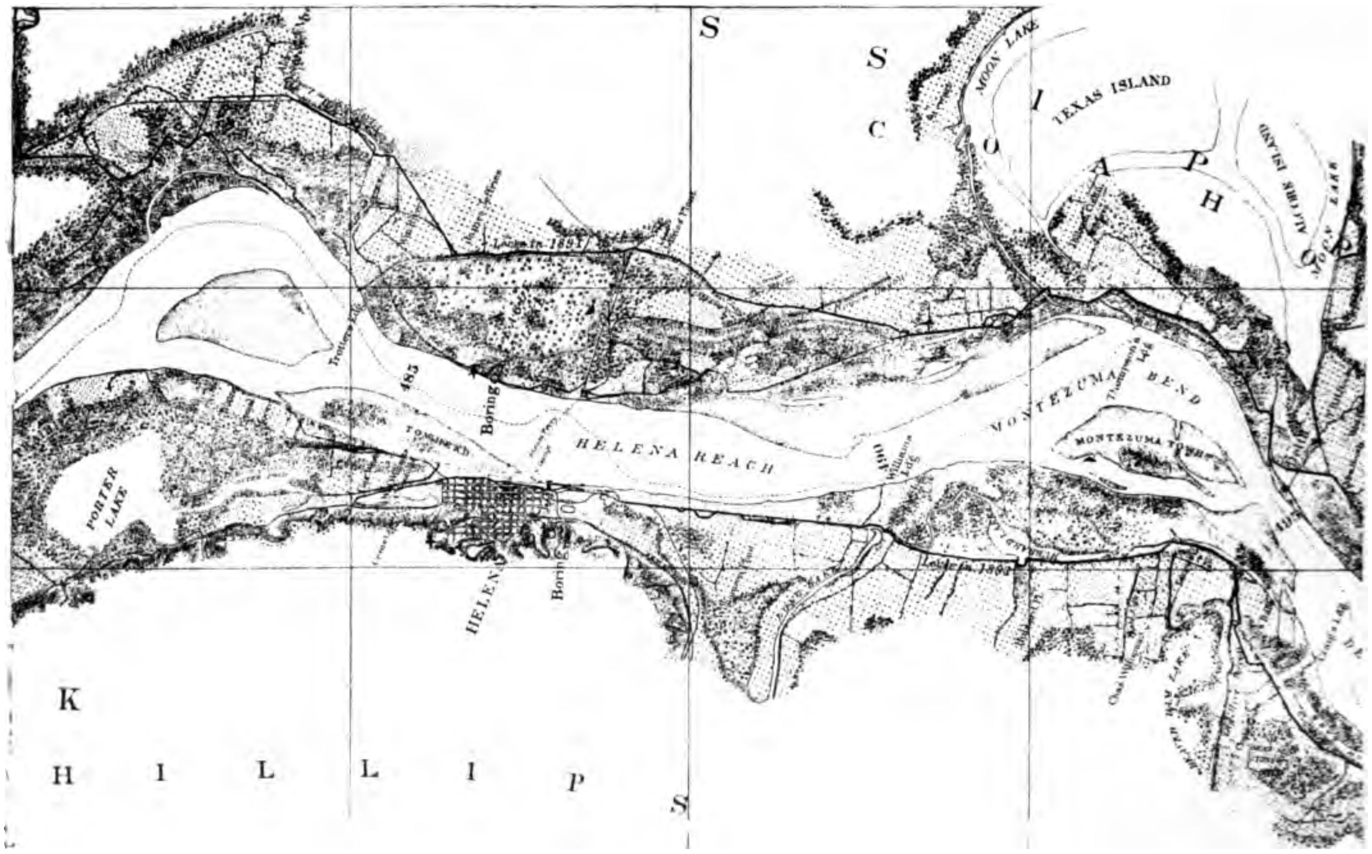
For population see page 352

JOSEPH C. BARLOW

Mayor of Helena, Arkansas

JAMES B. MILES

River Observer



MISSISSIPPI RIVER AT HELENA, ARKANSAS

J. B. PILLOW, President

W. N. STRAUB

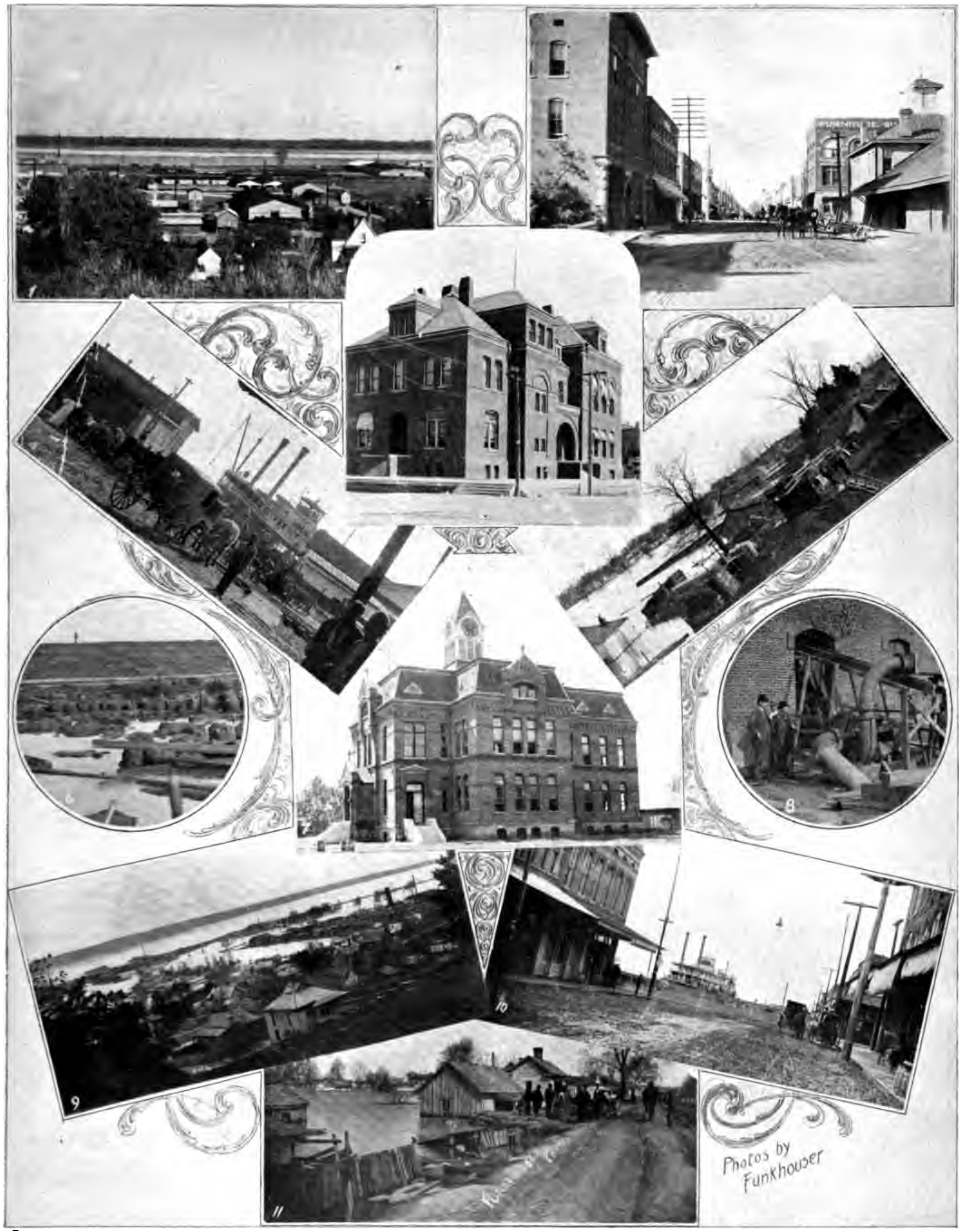
AARON MYERS, Treasurer

LEE PENDERGRAS

BOARD OF COMMISSIONERS HELENA (ARK.) IMPROVEMENT DISTRICT

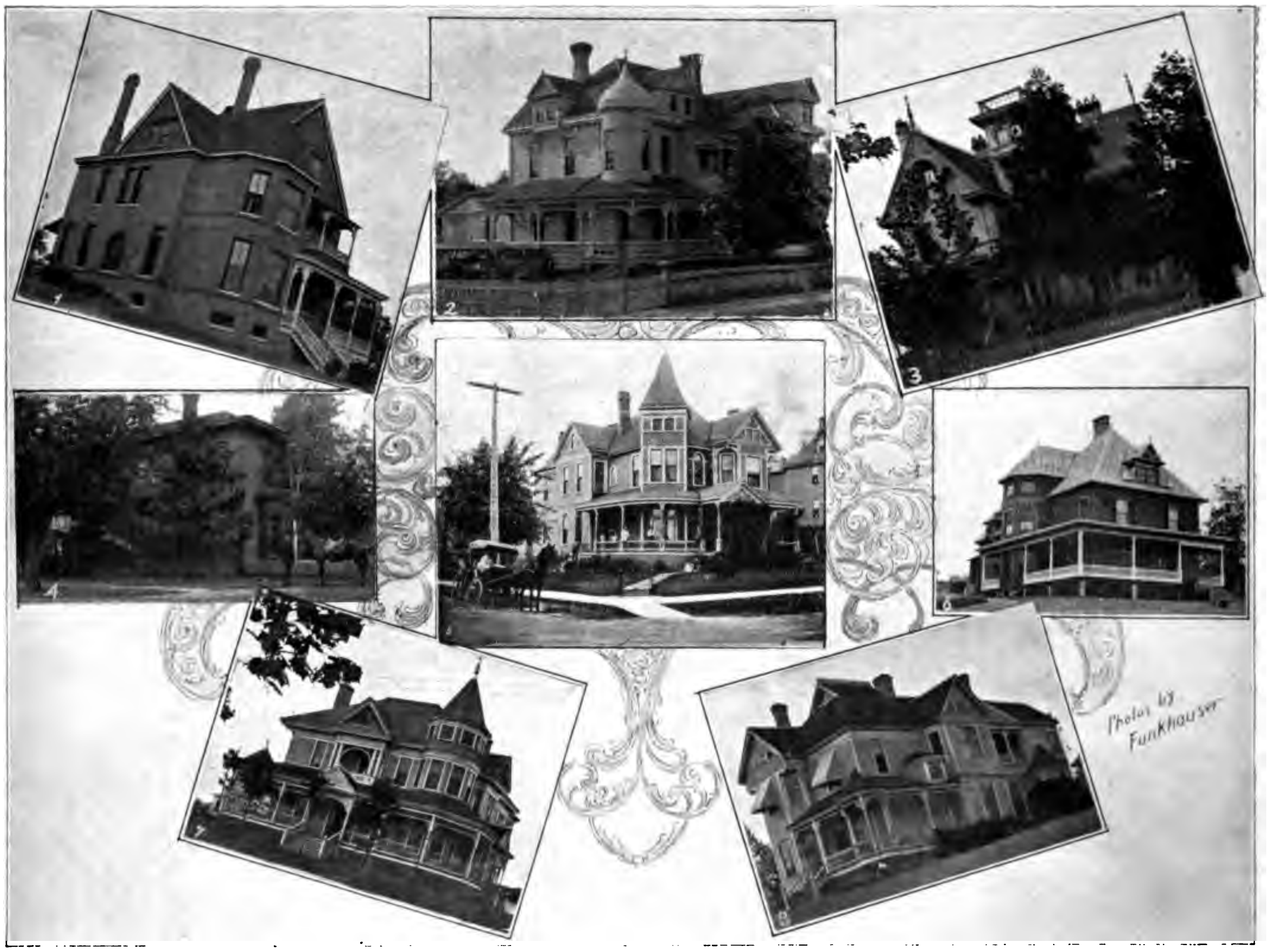
HELENA, ARKANSAS

The city of Helena is at the foot of the protecting hills known as Crowley's Ridge. It is one of the oldest towns in Arkansas, and is rated with the most prosperous of the same population in all the Southwest. South of the city lies the alluvial sections of Phillips county, of which it is the county seat. This county is noted as being one of the most fertile in the entire Mississippi valley, and having a very large number of highly cultivated plantations lying in what is known as the Cotton Belt Levee District. Helena has two railroads: a branch of the St. Louis, Iron Mountain & Southern, known as the Helena branch, which skirts the alluvial sections of the Mississippi River on the north, running along what is known as Crowley's Ridge, and through a country heavily timbered, and of exceptional fertility. The Arkansas Midland connects it with the interior sections of the state which lie west of it. It is a cotton market of large and growing importance. As an evidence of its growth in this direction may be cited the following figures: During the season of 1892-93 its receipts were 32,330 bales. In 1897-98 it had grown to 86,225 bales. The Helena Improvement District is a levee board which has charge of the protection of the city of Helena from the high water of the Mississippi River. The city is now surrounded by a splendid system of levees, built several feet above the high-water mark of 1897, which renders it absolutely safe from dangers in that direction. This protection is already having gratifying results in adding many fine brick business houses to the city, the improvement in that direction during the last few years having been very great. There are two fine compresses in the city to handle the large receipts of the fleecy staple. It has four oil mills—the City Oil Works, the Farmers' Oil Works, the Arkansas Mill and the New South—all of which are in a prosperous condition, and most of the capital stock is held by citizens of Helena. There are also several large wood-working plants of various kinds, such as lumber mills, stave factories, a box factory, and other manufactures of lumber in various forms. One of the most important industries is the Straub Pressed Brick Works, which ships its product to various sections of the country. Commercially speaking, it has a full complement of wholesale and retail houses, and does a large business of both kinds. It has three banks—the First National, the Bank of Helena, and the People's Savings Bank and Trust Company—which have ample capital to handle the large commercial and manufacturing business of the city. In churches and educational institutions it is fully abreast with places of its size, and a handsome United States building has been erected here for some years. An ample water supply for the city is afforded by a splendid system of water-works. The city also has a fine electric light and power plant. A move has been made recently in the direction of establishment of a comprehensive sewerage system. This is in the course of construction, and with the completion of this important improvement Helena will rank in its various facilities as a city of modern conveniences and conditions.



1 Bird's-Eye View of City
2 Street Scene
3 Government Building
7 Public School Building
4, 5, 6, 8, 9, 10, 11 Views of High Water, 1897

HELENA, ARKANSAS



Photos by Funkhouser

SOME OF THE PRETTY RESIDENCES OF HELENA, ARK.

THE SPORTSMAN'S PARADISE—ARKANSAS SCENES

Tennessee

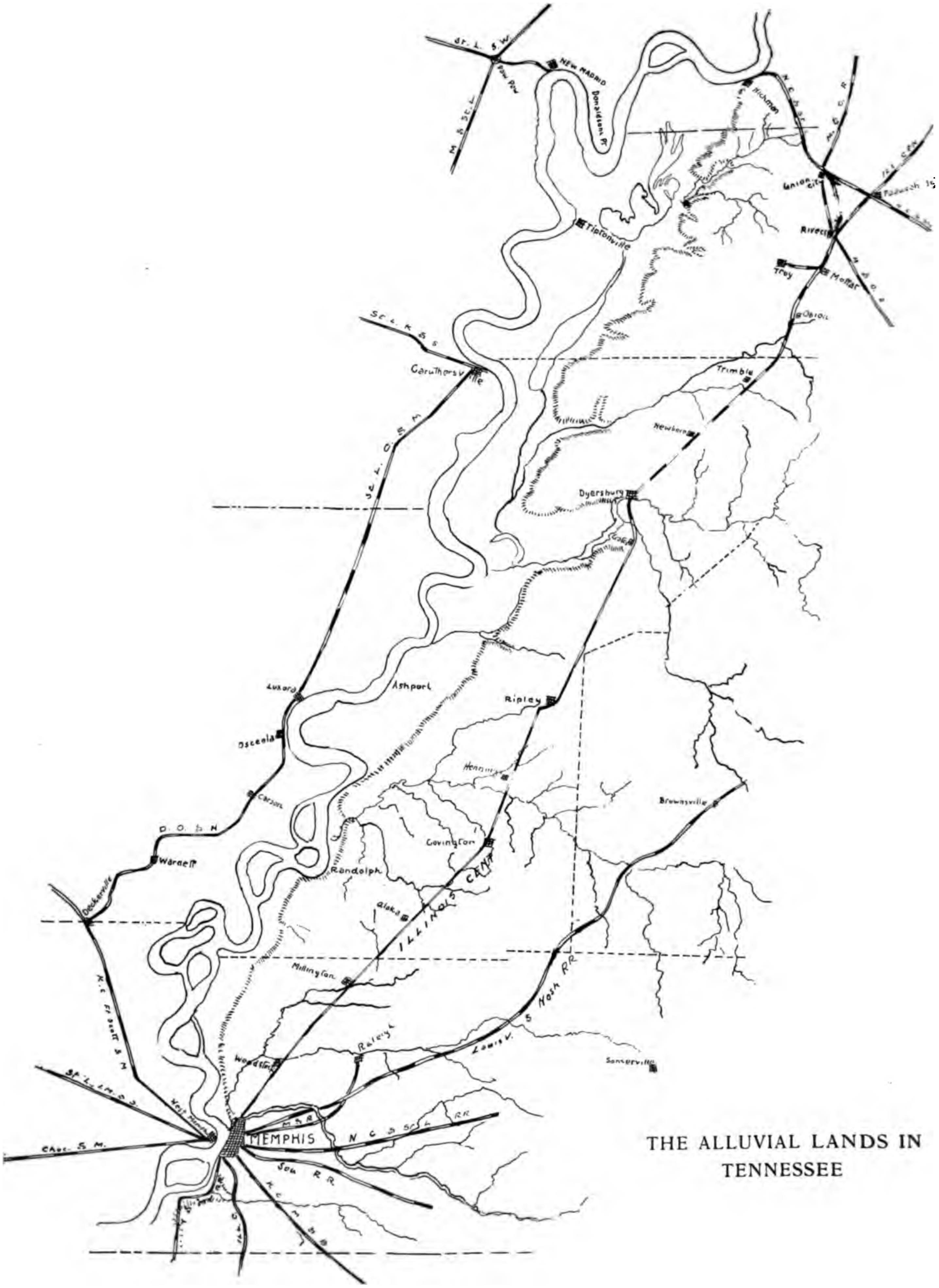
THE ALLUVIAL COUNTIES OF TENNESSEE

EXTENT AND VALUATION OF ALLUVIAL AND PARTLY ALLUVIAL COUNTIES

Counties	1880	1890	1899
Obion County	$2,829,560	$3.905.965	$4,659,935
Area, 339,439 acres, 40 per cent alluvial.			
Lake County	580,695	839,123	979,287
Area, 108,350 acres, all alluvial.			
Dyer County	1,917,415	2,099,133	2,545,425
Area, 313,779 acres, nearly ¼ alluvial.			
Lauderdale County	1,456,207	1,460,852	1.934,450
Area, 279,862 acres, about 20 per cent alluvial.			
Tipton County	1,990,322	2,041,565	2,149.390
Area, 267,112 acres, about ⅓ alluvial.			

The alluvial lands in this State lie in the counties of Obion, Lake, Dyer, Lauderdale and Tipton. Of these mentioned, Lake county is entirely alluvial. This county was formed by constitutional enactment in 1870, embracing that portion of Obion county west of Reelfoot Lake. In this county there are 10,000 acres of land above overflow, 85,000 subject to inundation from floods by the Mississippi River, and 15,000 acres covered with the waters of Reelfoot Lake.

Obion county, which has a total acreage of



THE ALLUVIAL LANDS IN TENNESSEE

339,439, is more than one-third alluvial. Dyer county has a total area of 313,779 acres, about 20 per cent of which is alluvial land. Three-fourths of these lands mentioned will be absolutely protected from overflow by the Hickman, Kentucky, and Slough Landing levee, which will be twenty and one-fourth miles long. Part of this is now under contract and is in the course of construction, and will doubtless be finished within the next year or two. The building of this levee is largely due to the energetic and persevering industry of James C. Harris, who is at the head of the commissioners having the enterprise in charge. The remaining one-fourth of the 200,000 acres, which lie in the alluvial belt in this section, will be greatly benefited by lessening the volume of water and breaking the current. Should the system of levee now commenced be continued from the high land at Tiptonville south to Ft. Pillow it would absolutely reclaim 400,000 acres of land, or 250,000 not protected by the Hickman levee. In Lake county there are 30,000 acres of land now in cultivation which produce from 1,200 to 1,800 pounds of seed cotton, or an average of one bale to the acre. The balance of this area will show equal fertility when fully protected from the floods. There is active agitation for a division of the Illinois Central Railroad around the river from Hickman, Kentucky, through Lake and Dyer counties to Dyersburg, Tennessee, with good prospect of being built.

The population of Lake county in 1890 was 5,275. It is now 7,368, most of which is of recent acquisition. With the finishing of the levees above mentioned this country will grow much more rapidly. The timber of this alluvial section is very heavy, and offers fine opportunity for the erection of wood working plants. There are already some very large sawmills in this section.

Tiptonville, the county seat of Lake county, is situated on a ridge or highlands on the Mississippi River, and is a place of considerable commercial importance. It has a population of about 600 and good banking and mercantile facilities. Its commercial importance is greater than its population would indicate, as it is the only trading place of any importance in Lake county and the shipping point for the cotton and lumber products of the county.

Especial mention may be made of the city of Dyersburg in this connection, which is a rapidly growing city on the Illinois Central main line from Cairo to Memphis. The following short sketch of Dyersburg and Dyer county is furnished by the kindness of Col. Tom W. Neal, the editor of the Gazette of that city:

Dyersburg, on the Illinois Central Railroad, is located at the head of navigation on the Forked Deer River, contains about 4,500 population, is easy of access by good roads from all parts of the county; has three substantial church edifices, an Odd Fellows and Masonic halls, one of the finest and best public schools in the State, at which the children of the entire district are educated free of charge. The faculty of this school is an admirable one, and consists of seven first-class teachers. Here we also have a splendidly equipped steam sawmill, a fine first-class planing mill, two newspapers, one of the finest steam flouring mills in the State, three hotels, two banks, a tobacco manufactory, two wagon factories, a first-class factory for the manufacture of slack barrel staves and headings, a fine cotton seed oil works, with the latest and most approved machinery, a new machine works equal to every demand made on it, and about fifty other firms.

Dyersburg is fortunately located for a manufacturing town. There are lands in Dyer county that will bring over a bale of cotton to the acre, while all of the land is very fertile, being well adapted to the production of tobacco, fruits, grain and vegetables.

No town in Tennessee has a more promising future before it than Dyersburg. The shiretown of certainly one of the most productive counties in the State—at the head of steamboat navigation on the Forked Deer River, which empties into the Mississippi at Hale's Point—far enough from any city to prevent any dangerous rivalry, and near enough to enjoy all its advantages—the very best facilities are now offered in this favored section to capitalists who desire to engage in manufacturing pursuits of any kind, and the citizens would welcome and co-operate with any parties who would locate here for that purpose. Dyersburg is seventy-six miles from Memphis and is increasing in population, wealth and importance. It already feels the inspiration of a bright future, and the outlook says now is the time for capitalists seeking investments, or those in search of new, pleasant and profitable homes, to see the town and make permanent investments therein. Farmers seeking a Southern home will make no mistake if they locate near Dyersburg. Dyersburg is also a modern city, with electric lights, water works, first-class military company, and everything to entitle it to that appellation.

Dyer county land yields from a half to one and a half bales of cotton, and from twenty to fifty bushels of corn per acre. Wheat is also very successfully grown. Plenty of excellent fruit is raised in every section of the county, while the best grasses in the world can be raised in great abundance.

There is plenty of the best wild land to be bought at from $5 to $10 an acre. In fact not one-tenth of the land has ever been under fence or cultivation. Improved farm lands are worth from $10 to $45 per acre. Society is peaceable and hospitable. The soil produces abundantly, and no one need remain poor who will plow and hoe with energy and earnestness. As for health, the chances are as good here as any place South. The people are strictly an agricultural people, raising cotton, tobacco and grain, and giving some attention to raising cattle, hogs and sheep. Few horses or mules are raised beyond home wants, but some of the best farmers have embarked in the stock business, and in a few years many of the blooded horses and best mules of the country will be raised in Dyer county. Water power is good and plenty. Fortunes can be made here by erecting flour and saw mills, while cotton, furniture and wagon factories, the raw material for which can be found here in abundance, would probably be still better investments. Capitalists in search of a place to invest their funds should not pass over Dyer county and its shiretown.

The assessed value of Dyer county in 1890 was $1,917,415. In 1899 it was $2,545,435, or an increase of nearly $600,000.

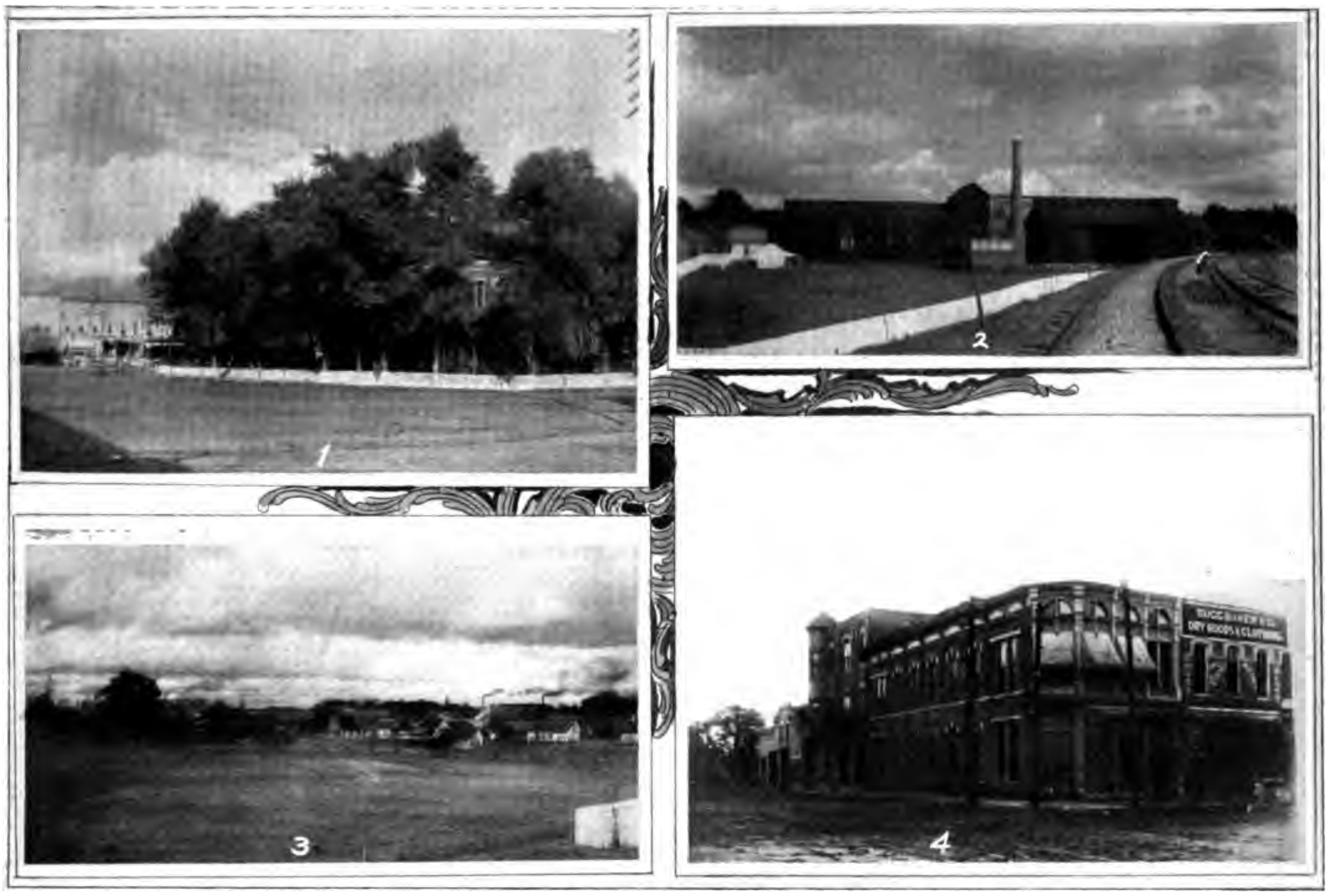
Obion county, of which the enterprising and growing little town of Union City is the county seat, had in 1880 an assessed valuation of $2,829,560. In 1899 it nearly doubled, being $4,659,935. Union City is a well built place on the Nashville, Chattanooga & St. Louis and Mobile & Ohio railways, having many industrial enterprises, and doing a very large wholesale and retail business with the contiguous upland sections of Tennessee and Kentucky, as well as the alluvial sections of both states. Its present population is 3,407.

Lauderdale county, which lies south of Dyer county, has a total area of 279,862 acres, of which not quite 25 per cent. is alluvial. It had in 1890 an assessed value of $1,460,852, which was increased in 1899 by nearly one-half million dollars, amounting to $1,934,450. The county seat of this county is Ripley, which is a thriving and growing place, showing much industrial and commercial activity.

Tipton county, of which the county seat is Covington, has a total area of 267,112 acres. In 1890 its assessed valuation was $2,041,565, and in 1899 was $2,149,390. The alluvial lands in this county comprises about one-third of its area, nearly all of which is overflowed in times of extreme high water by the Mississippi River, and no doubt the small increase in its assesssment is attributable to this fact. When protected by levees this county will show the same rapid increase which has characterized the better protected counties in Arkansas, which lie opposite.

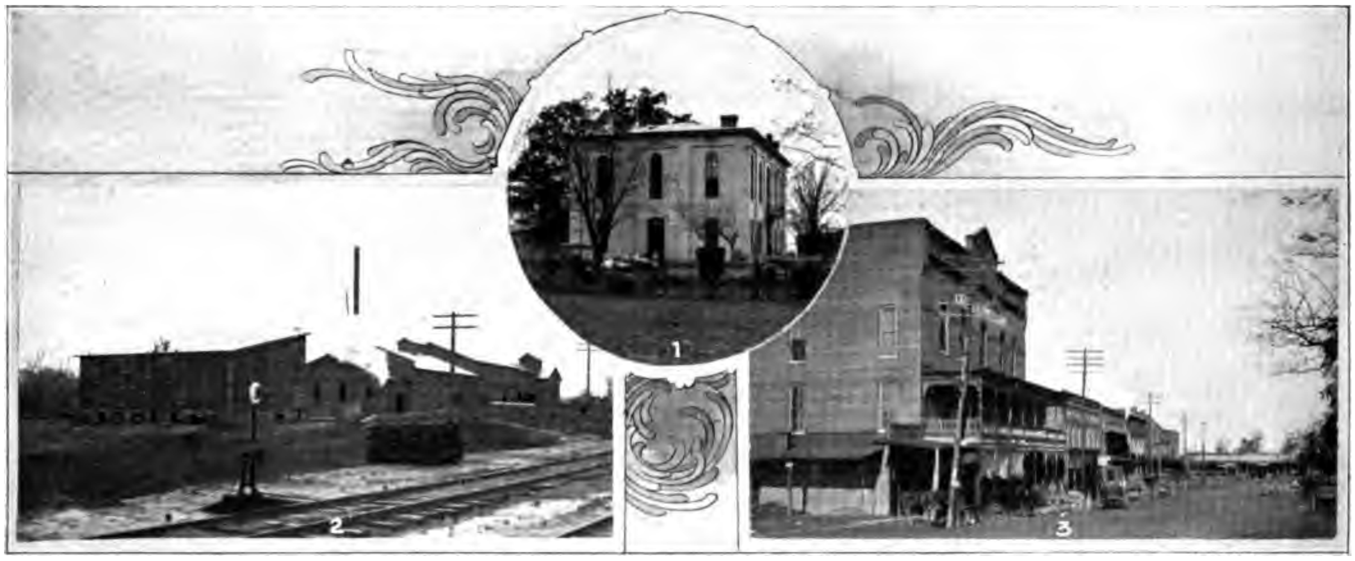
As before mentioned the county seat of Tipton county is Covington, which draws a large business from the surrounding country. It is a place of growing importance, and of considerable commercial and industrial prestige. Here there has been recently erected a large cotton compress, of which an illustration is given.

A map is given, in this connection, of the section lying between Cairo and Memphis, showing the alluvial sections of Tennessee and Kentucky; also maps of the different counties accompanied by statistics of population of 1880, 1890 and 1900.



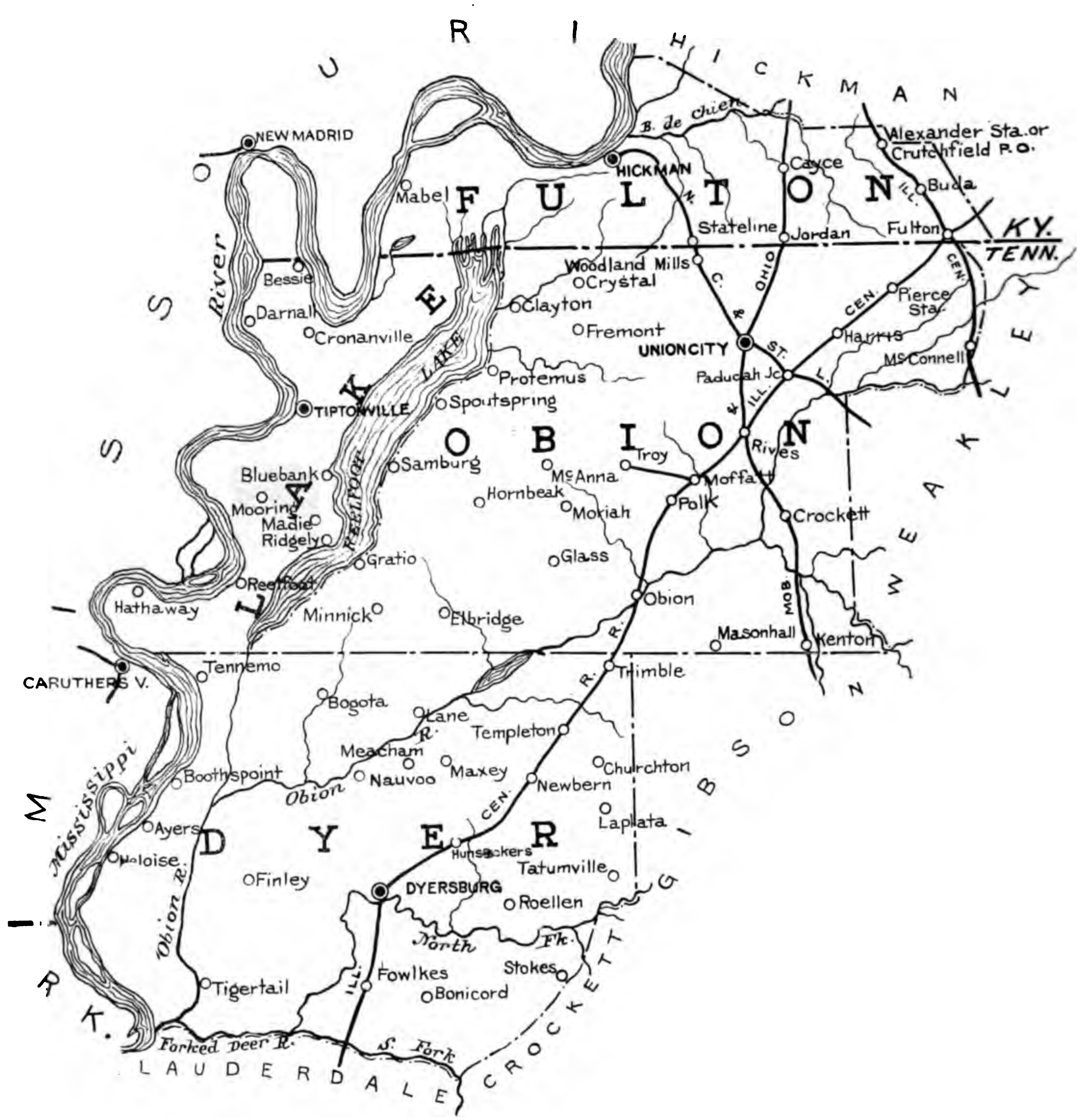
1 Court House. 2 Elevator. 3 Bird's-Eye View from Railroad. 4 Citizens Bank

VIEWS OF DYERSBURG, TENNESSEE



1 Court House. 2 Ripley Oil Works. 3 Main Street

VIEWS OF RIPLEY, TENNESSEE



LAKE, OBION AND DYER COUNTIES, TENNESSEE

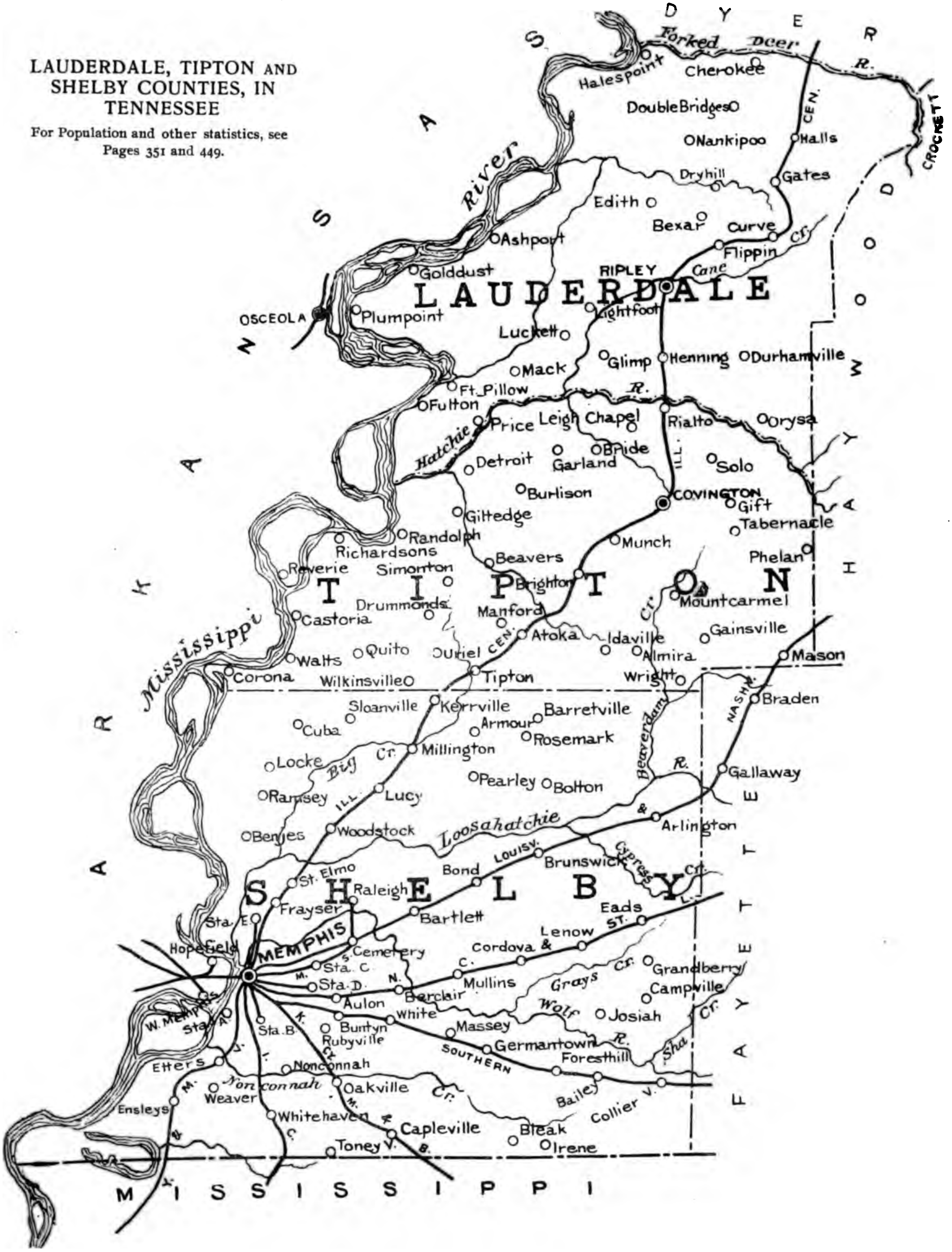
For Population and other statistics, see Pages 351 and 449.

FULTON COUNTY, KENTUCKY

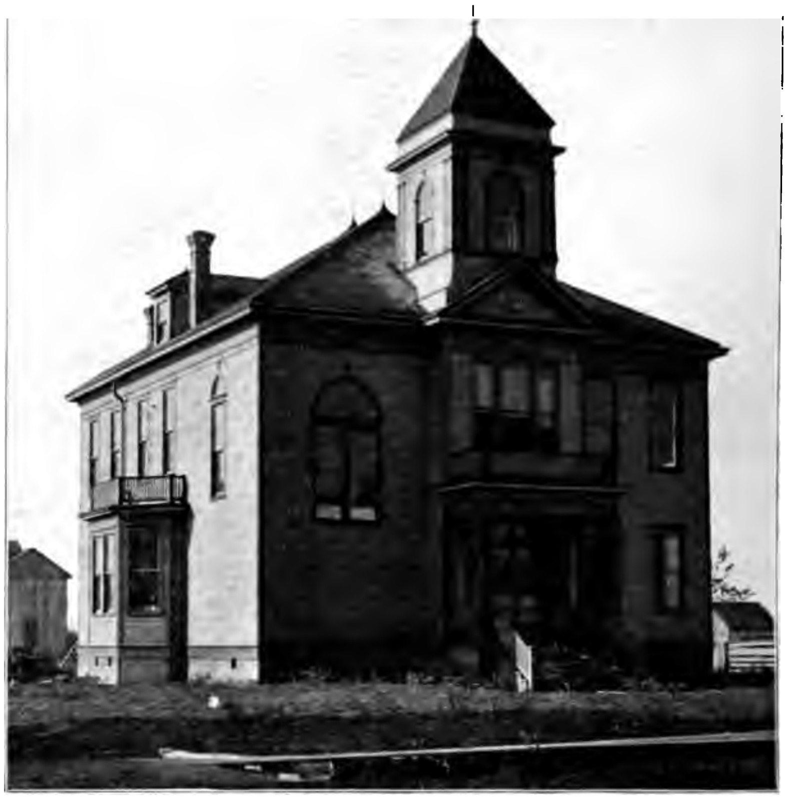
Population,	1900	11,540
"	1890	10,005
"	1880	7,977

LAUDERDALE, TIPTON AND SHELBY COUNTIES, IN TENNESSEE

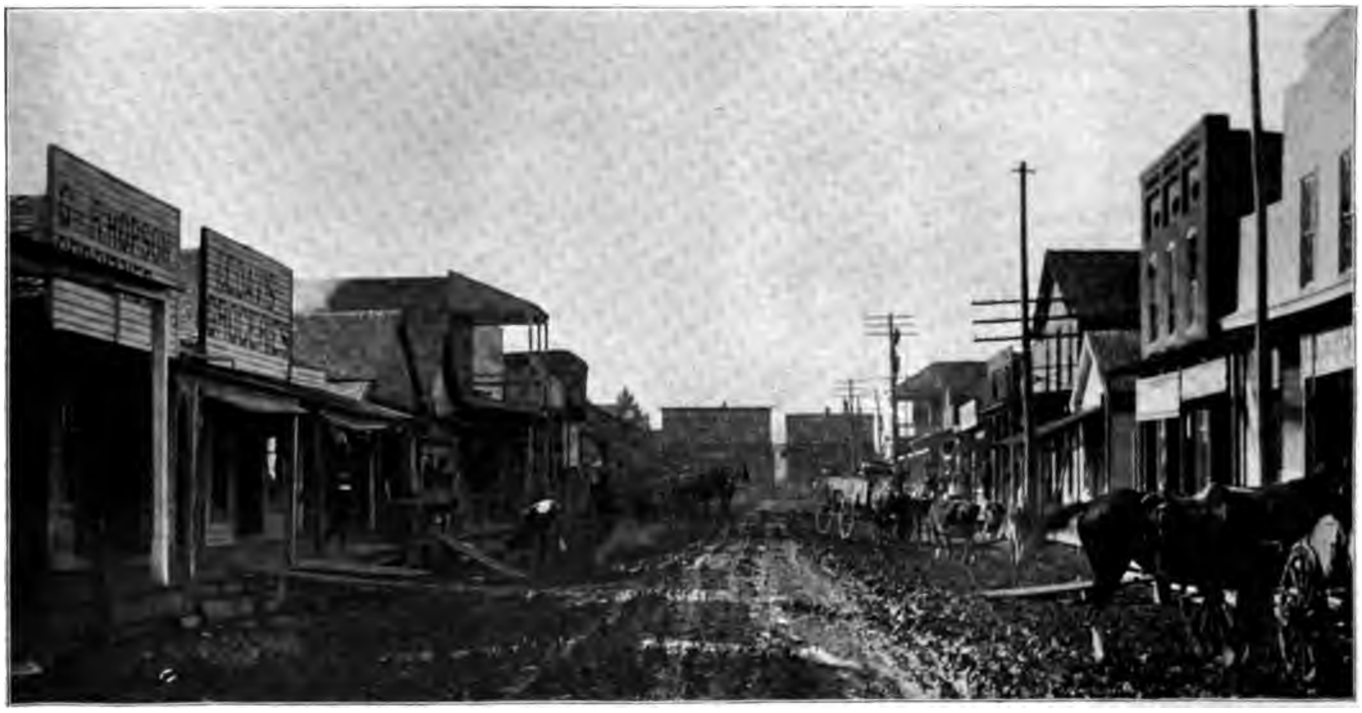
For Population and other statistics, see Pages 351 and 449.



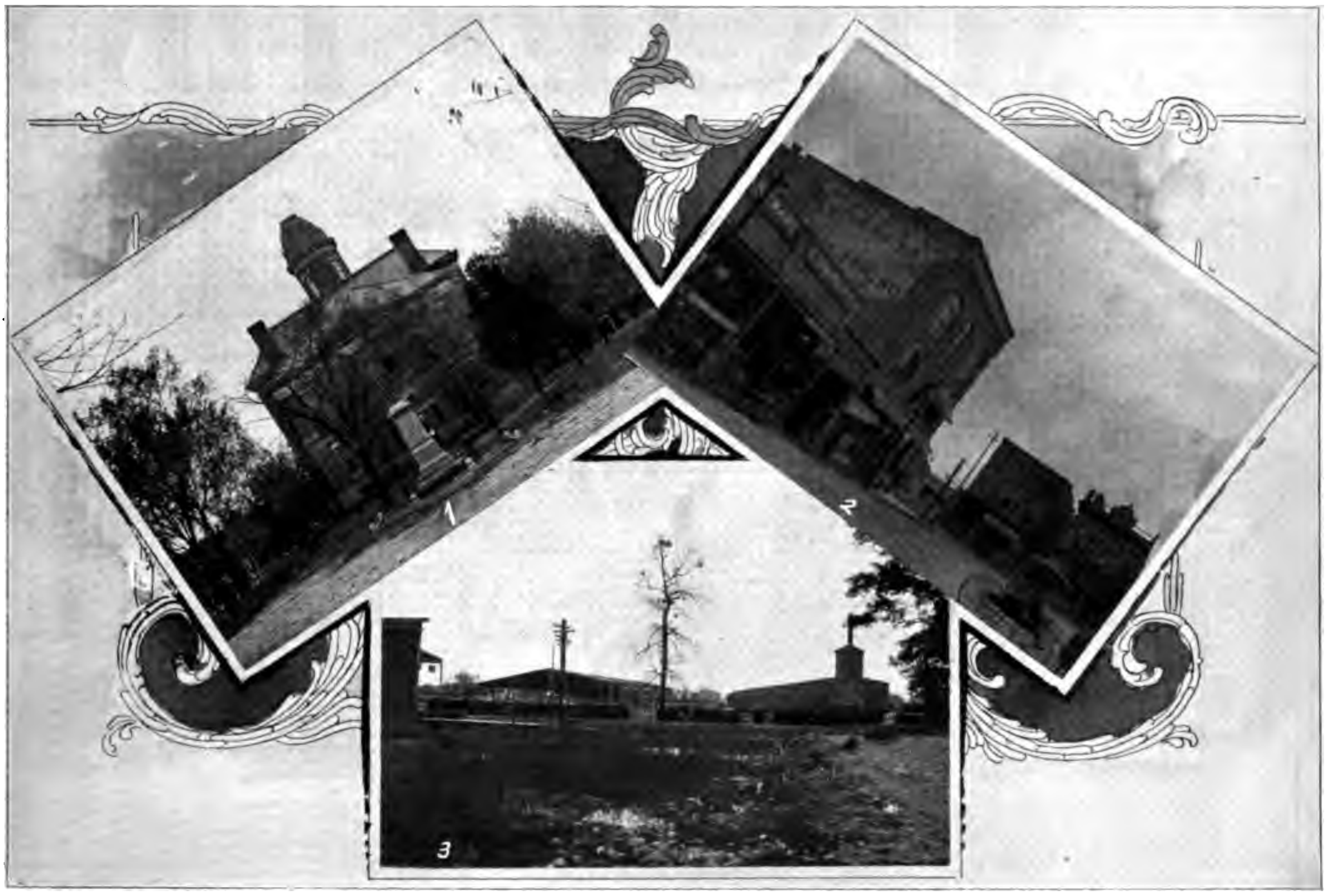
JAMES C. HARRIS
President Hickman and Tiptonville Levee Association



COURT HOUSE AT TIPTONVILLE, TENNESSEE



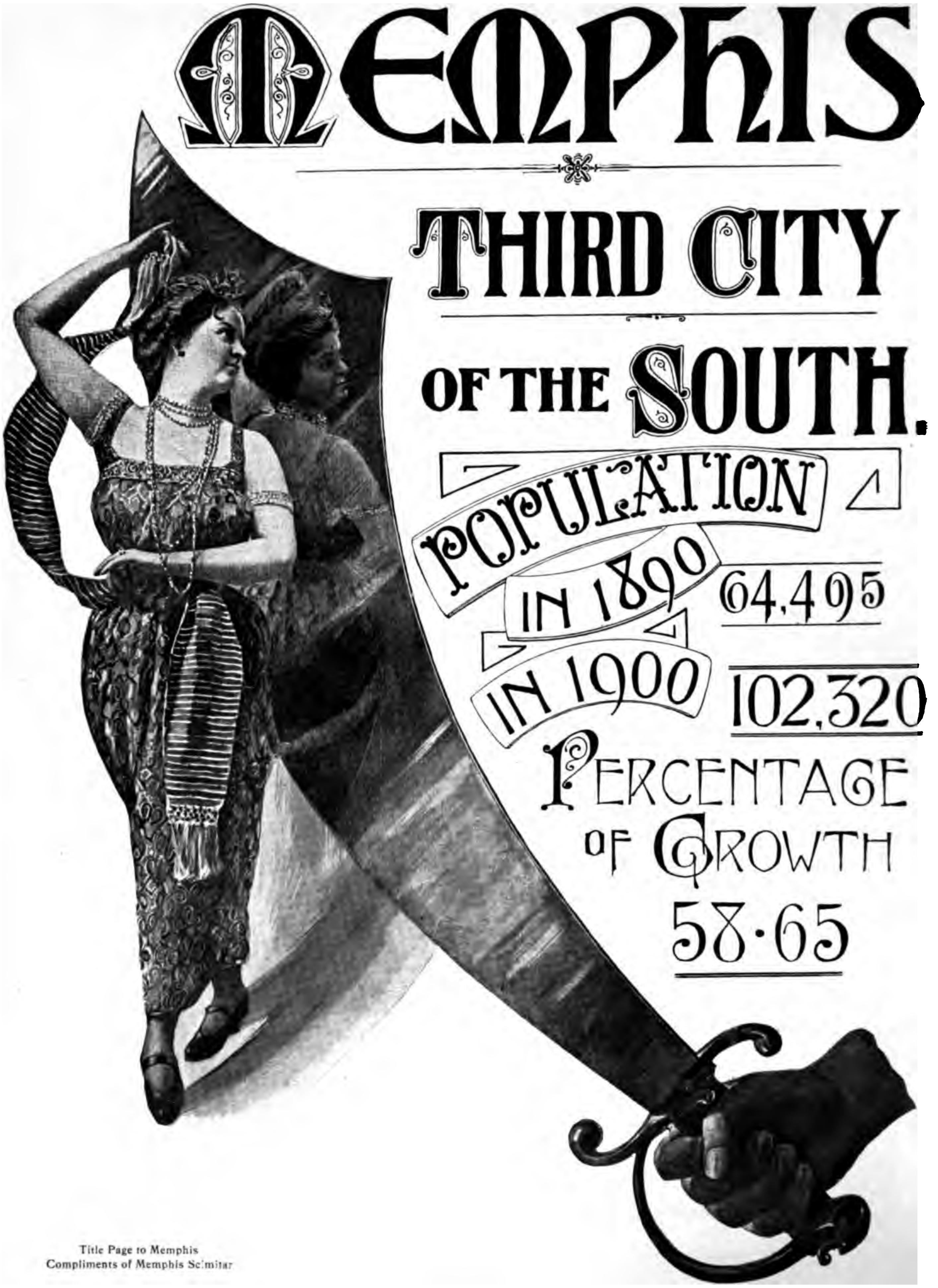
STREET SCENE AT TIPTONVILLE, TENNESSEE



1 Court House. 3 Cotton Compress. 2 Street View

VIEWS OF COVINGTON, TENN.

DE SOTO DISCOVERING THE MISSISSIPPI RIVER



Title Page to Memphis
Compliments of Memphis Scimitar

MEMPHIS

BY GEORGE W. FOOSHE, COMMERCIAL EDITOR SCIMITAR

GEORGE W. FOOSHE

The growth of Memphis from the small Indian trading post away back in the younger days of the century now ending to the great commercial city which she is to-day, is one of the most remarkable in the history of Southern cities, and nothing shows more conclusively the wonderful possibilities of the Riparian Lands of the Mississippi and the great country that belongs to the basin in which Memphis lies than does the steady growth and development of the "Queen of the Valley," the Bluff City overlooking the father of waters.

There is one remarkable feature about Memphis that belongs to scarcely another Southern city. She is simply a commercial city and nothing more, and she has always been. Other cities boast proudly of their numerous libraries, art studios, educational institutions, and all that goes to make up the cultural element that brings into existence what Matthew Arnold has so beautifully called "Sweetness and light," but Memphis, while not neglecting the cultural altogether, has centered almost her entire energy and strength in the development of her commercial interests, until to-day there is not another city of the same population in the United States that transacts the same amount of business per capita as does this city.

There has been nothing of the mushroom growth that has characterized some of the Western cities, nor has there been any of the backward movement in the path of progress that belongs to some of the distinctly Southern ones. The development has been slow, steady, strong and powerful enough to overcome the ravages of war as well as the pestilences that God has sometimes visited upon her. Yellow fever came near wrecking her and turning the tide of progress from the flow to the ebb, but since the late Col. Geo. E. Waring did his wonderful engineering work after the scourge of 1878, and now that sewers traverse almost every portion of the city, and now that the health authorities have the ability to enforce quarantine restrictions against all epidemics at other points, the city is as healthy as any in the South, and business enterprises once afraid of Memphis are now eagerly seeking to locate here.

While the city has assumed a high rank among all industrial and commercial cities, and while every branch of trade and industry has made its contribution to the high position the city occupies, the cotton trade, the cotton seed oil business and the lumber trade stand pre-eminent among these.

Memphis has for long years enjoyed the distinction of being the largest inland cotton market in the world. Situated in the most fertile section of the cotton belt, standing at the head of all the year round navigation of the Mississippi, she was the natural market to which the planter of ante bellum days brought his cotton on wagons or on the occasional steamers that plied between New Orleans and St. Louis. She was the nearest large city in reach of the planter, and the only one from which he could carry back the supplies and implements necessary for the conducting of farming operations. Time was not a factor in those days. But there came a change with the war. The large plantations were broken into smaller ones, and marketing had to be rapid. The river packets were increased in number. At the same time the building of railroads received a wonderful impetus from the development of the cotton growing industry, and those that sought the trade of the territory had their lines to pass through this city.

Time became a consideration, and planters, instead of coming to this city to sell their cotton, consigned it to factors here, who sold it for them on commission. The business was of rapid growth until now there are 55 sellers or factors in this city, with warehouses of sufficient capacity to shelter all the cotton that finds its way to this city. The eleven lines of independent railways, competing among themselves as well as with the numerous packets on the Mississippi, gradually brought about reduced rates, which brought more and more cotton each year, until the receipts for the year just ended were 596,545 bales.

The establishment of the Cotton Exchange has done much to develop the market. Up to 1873 there was no exchange in this city, and Memphis played only a minor part in the outside cotton world. But with the establishment of this the city rapidly forged to the front as a distributing center.

Every marketable variety of staple was to be had here with the exception of the Sea Island. "Benders" from the interior counties of Arkansas and Mississippi were to be had in large quantities, while other exclusive staples attracted world-wide attention. The Cotton Exchange was a guarantee of promptness and perfection of standard. Thus it came about that representatives of prominent cotton houses in the United States came here, as well as those from Liverpool, the continent and every manufacturing cotton center in the old world. The result has been the sharpest competition among buyers and sellers, and the shipping of cotton to the mills of the North, the South, Canada, Bremen, Havre, Liverpool, Manchester and other foreign cotton centers. The advantage of cheap rates, both to and from Memphis, as insured by the competitive railways with their connections leading to all the Atlantic and Gulf ports has attracted both buyers and sellers here, since cotton can often be shipped direct to foreign ports at lower rates than from New Orleans and other port cities.

The large number of buyers (56) has brought about the most intense competition, which guarantees to the planter the highest price his cotton could command. Owners of the large plantations in the Mississippi Valley do not sell in the small markets within easy reach of them, because there are none of the cotton experts there who will give them the full market value of their holdings. They ship into Memphis, where men who have devoted a lifetime to the cotton business sample it and give prices according to the grade of the staple. This has had a wonderful influence on the growth of the city's cotton trade. Year by year the factors handle a larger percentage of the cotton crop, drawing it from bounds even beyond the 150 limit allowed to the Memphis district proper.

That Memphis is an important cotton center is attested strongly by the fact that there are sent out daily cablegrams and telegraphic advices to every cotton market of the world. Memphis handles about 6@7 per cent of the entire cotton yield of the United States, and in this capacity has a right to speak, and what she says has a powerful effect on the speculative markets. Bad news from the Memphis district is always the signal for a bull campaign, while too good reports from the section start bear operations on a scale that is rather disheartening to the planter at the South.

But what Memphis has been and is is not what she is destined to be. Her progressive citizens recognize the commercial importance of the cotton crop, and since they do recognize this they are gradually reaching out into new territory, bringing larger receipts to this market. The last railroad, the Choctaw, Oklahoma & Gulf, taps a fertile section of the Arkansas side of the valley, and the receipts hitherto small from that section are expected to add materially to the total amount handled here in the years to come. At the same time the trend of the manufacturing of cotton goods is toward the South, and this will help the cotton trade of Memphis to a degree that was not only improbable but absolutely impossible less than a decade ago. The Memphis wholesale merchants are reaching out into new territory daily, and wherever a Memphis merchant sells his goods the cotton from that section finds its way to this market and helps to swell the total volume of business done.

The industry that competes in most active rivalry with the cotton trade of Memphis is her lumber interests. This is as yet a comparatively young business, though the growth of it has been so rapid that it has already assumed proportions that are by no means inconsiderable. Situated in one of

W. A. GAGE
President Memphis Cotton Exchange

HENRY HOTTER
Secretary Cotton Exchange

J. W. THOMPSON
President Memphis Hardwood Lumber Association

LEE MALLORY
President Memphis Merchants' Exchange

N. S. GRAVES
Secretary Memphis Merchants' Exchange

J. J. WILLIAMS
Mayor of Memphis

THE LATE DR. D. T. PORTER

A. S. CALDWELL
rman Committee on
Greater Memphis

BENTON M'MILLIN
Governor of Tennessee

THE LATE R. C. GRAVES

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tput goes for export purposes to Europe and the United Kingdom, while the 60 p cent remaining is taken by the domestic consum tive trade. The gross business, according to figur obtained at the Merchant's Exchange, amounts $8,091,666 annually, while the capital invested lands and plants reaches $4,306,175. The number of feet handled amounts to 337,333,350, and the number of hands employed to 4,366. The number of cars handled reaches 31,574, while the average price per 100 feet is $28.77. These figures, it must be understood, refer only to the business of Memphis proper and not to the Memphis district. Were figures obtainable for the latter the total in every item would be very materially increased.

There is almost no limit to the kinds of wood to be had in the timber belt contiguous to the city. There is nearly every variety of tree for the manufacture of hard wood, and though the blow of the axman is heard in the forests and the hum of the saw at the hundreds of mills, the resources of this belt remain practically inexhaustible and there is every reason to believe that Memphis will for years to come hold the position as the largest hardwood market in the world. At the same time, on account of the access to the soft woods of Arkansas, made possible by the opening of the Choctaw, Oklahoma and Gulf railroad, there are some well informed lumbermen of this city who are confident that Memphis will not only hold the palm as the largest hardwood, but also as the most important lumber center of the world. The most logical reason for this prediction is the fact that the giant forests of the West and Northwest have been exhausted, and plant after plant is coming to the home of the timber just as the cotton mills of the North are seeking location in the heart of the cotton belt.

The other industry in which Memphis ranks first among the cities of the world is the manufacture of cotton seed oil and meal, her mills annually furnishing more than one-twentieth of the entire cotton seed oil output of this country. The cotton oil milling industry was attempted during the latter part of the eighteenth century, but despite the encouragement offered by societies for the development of arts and commerce, the business was not put on a practical basis until about two decades ago. This industry belongs peculiarly to the South, on account of the fact that the weight and bulk of the seed exclude shipment to other manufacturing sections, and Memphis, located in the richest cotton producing section in the South took hold of the business in its infancy. The first mill was erected before the civil war, and others, foreseeing the great field offered, put up other plants, till to-day there are plants as fine as any in the South, with a total daily crush of 1,350 tons when their full capacity is used.

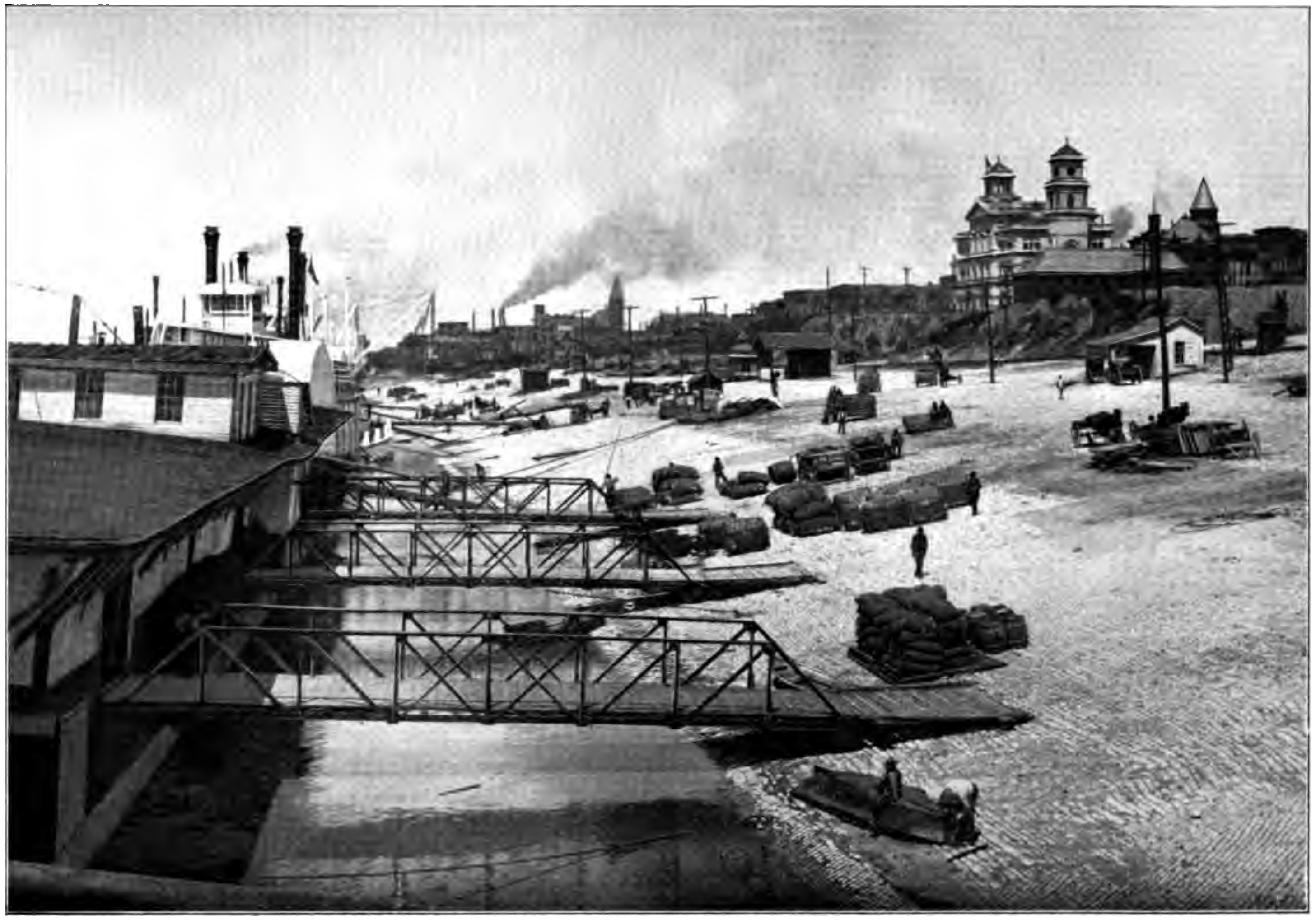
While the growth of the business was rapid, and Memphis soon outdistanced all competitors, it was not all smooth sailing. There came a great slump in the price of the oil. The formation of the A. C. O. Co. saved the situation by putting prices to a higher level as well as by developing the industry to such an extent as to make it possible to use every particle of the seed, now known as the by-products. Machinery was manufactured for reginning the seed, and the offering of the "linters" on the market. The hulls went as fodder to the cattle, while the mills sold their meal for cattle feeding and for fertilizer purposes. At the same time a cotton fiber company for manufacturing the hulls into pulp, to be used as the body for paper, was established. Another source of profit came in the broadening of the uses of the oil, large quantities going into the manufacture of soap, compound lard, and into other legitimate trade channels. The Memphis mills represent an investment of more than $1,000,000 and do an annual business of more than $1,500,000, and both the investment and the annual output are gradually increasing. Two of the plants this year added 1,500 tons to their daily crushing capacity, while all the mills have recently put in the most improved machinery at a considerable increase of cost over the original outlay expended. At the same time new territory from which seed are being drawn and the more favorable rates from Arkansas are gradually adding to the increase in the annual volume of business. The output of the Memphis mills are sold in both the domestic and foreign markets. The chief American consumptive points are St. Louis, Cincinnati, Chicago, Providence, R. I., and New York.

A source of pride to Memphis is her banking institutions. She has six commercial banks and five savings ones and these, especially the former, are easily able to finance the large deals made in cotton, lumber, groceries and supplies and in other less important lines., It is to their credit that they have been able to weather the financial storms that have swept the country in recent years and that their depositors have not had to make howling rushes on them for the safety of their money. It is also worthy of note that during 1899-1900 the deposits in the commercial and savings banks reached the highest figures in the history of the Bluff City, and that the business transacted through these banks during the same period, as given by the Clearing House reports, showed an increase in round numbers of $26,389,000. The banking business of Memphis is in the hands of wise, prudent and progressive men, who are always on the qui vive for something better for the city, and now that the volume of business is increasing so rapidly, they are using all their efforts towards bringing a sub-treasury here.

The grocery and general supply business of Memphis is by no means inconsiderable. Transacting a business of $20,000,000 to $30,000,000, she is recognized throughout the United States as the ninth and at the South as the second distributing center among Southern cities. Front street, the home of the wholesaler, is a beehive of industry, and the men who control the wholesale houses are steadily reaching out into new territory. Already they control all of Mississippi and the larger portions of Tennessee, Arkansas, Oklahoma and Louisiana. The competition with St. Louis and New Orleans is sharp sometimes in parts of these States, but the traveling men from the two latter cities, with whom the writer has talked recently, acknowledge without hesitation that they dread more and more the successful rivalry of the Memphis salesmen. Memphis cotton factors are widening the area from which they draw their cotton, and Memphis grocers easily follow into the territory from which the fleecy staple finds its way to the Bluff City.

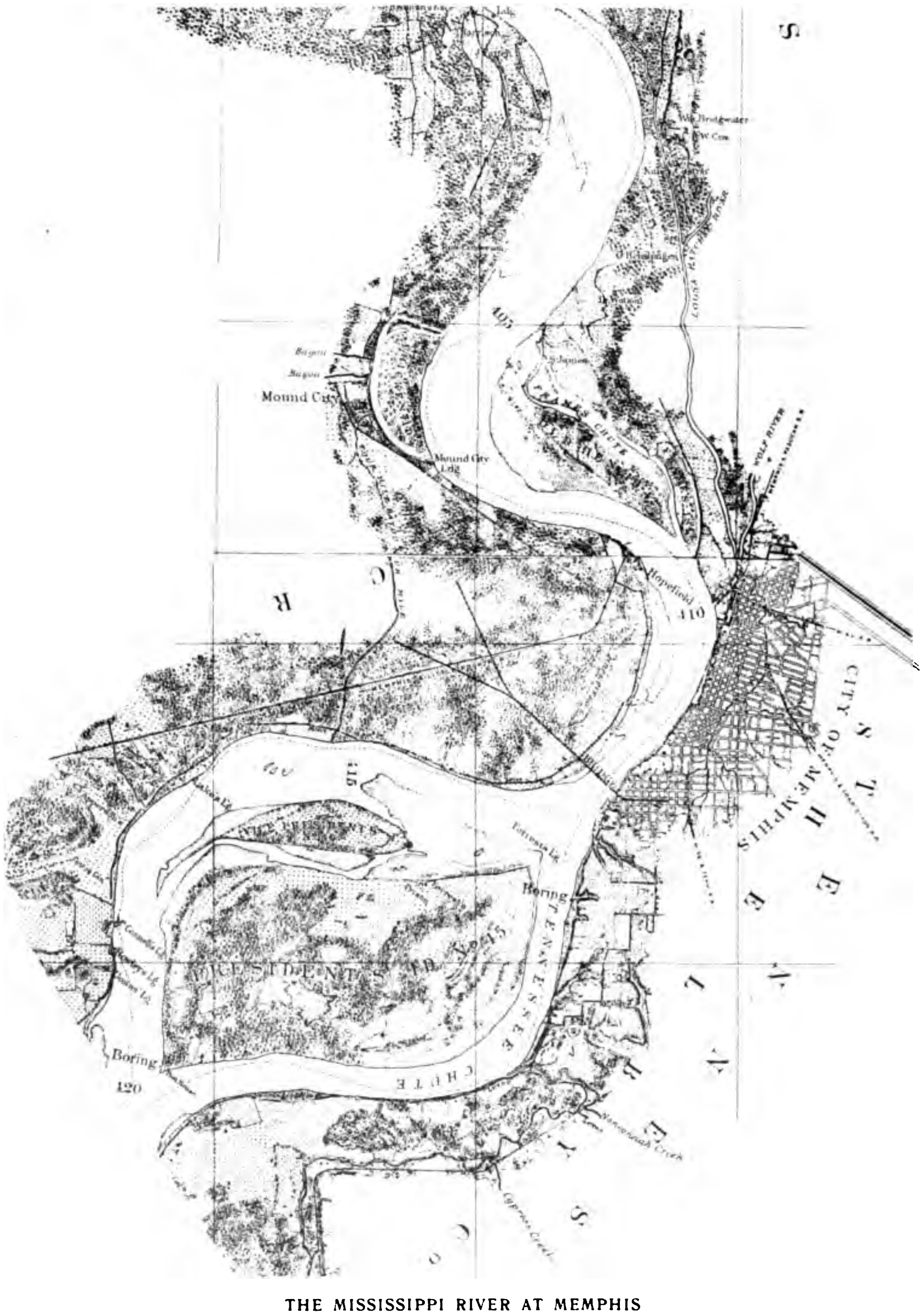
The manufacturing enterprises of the city already pass the 500 mark, and plans are now on foot for the attracting of new plants here. The organizations in charge of the efforts in this direction are well equipped now, and, being in a position to offer the most favorable concessions in the way of building sites, side trackage, etc., the best of results are expected to follow, and new enterprises are expected to locate here much more rapidly than in the past.

There are other notable features about the commercial history of Memphis, but these must be passed over with the cursory remark that they are steadily developing and that the Bluff City, over-

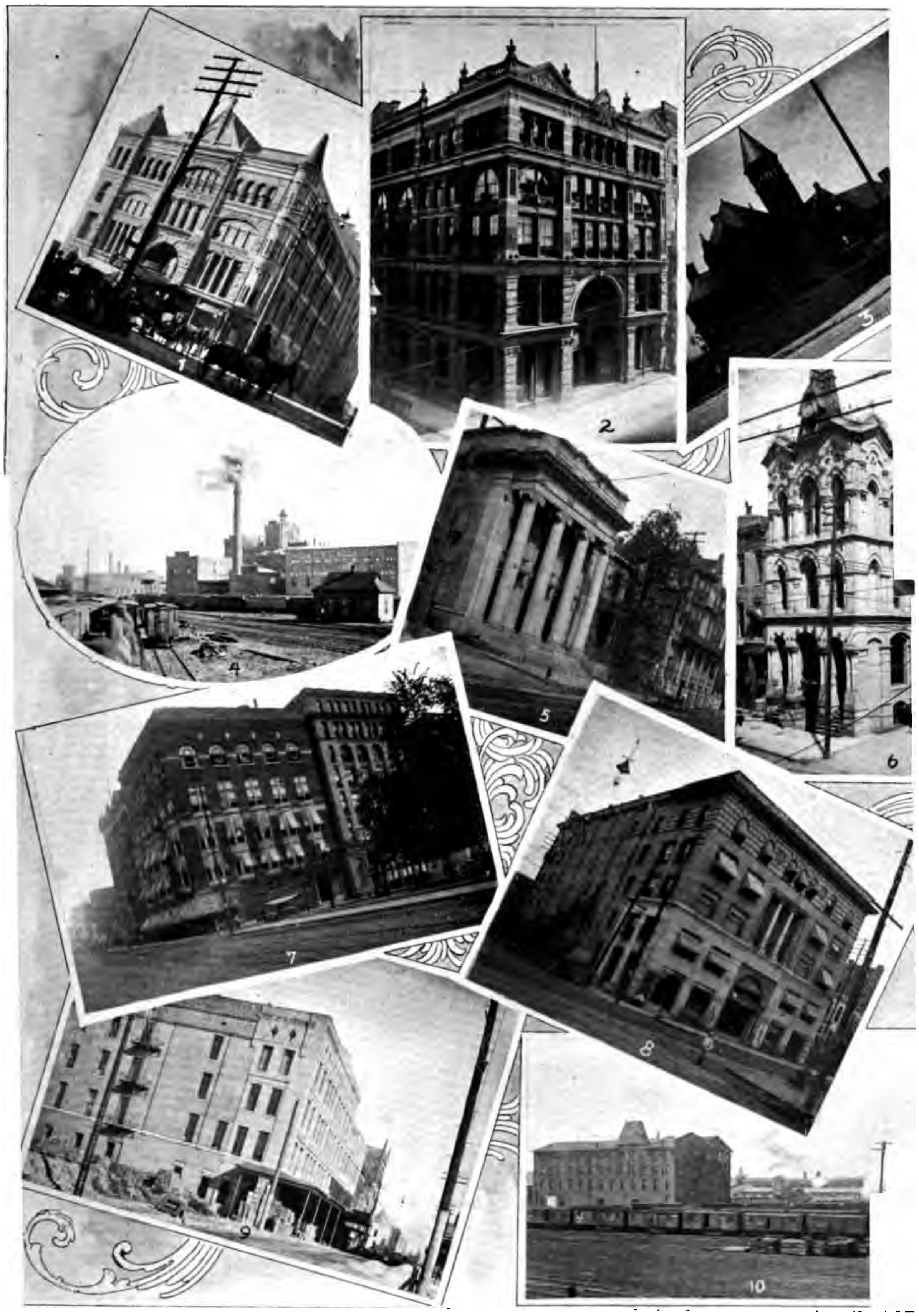


ALONG THE LEVEE, MEMPHIS, TENN.

looking the Father of Waters, is by no means in the zenith of her commercial development. With her progressive citizenship filled with pride at the rapid strides of the past decade, with her merchants and cotton factors reaching out into new territory, with new lines of railway seeking this city as the "Gateway" of the South, with her levees improved by the aid of the Mississippi River Improvement and Levee Association, the past is only an earnest of what is to be, and, while Memphis may never be the first city of the South in population, she will always be the "Queen of the Valley, God Bless Her," and stand ahead of all her rivals except the Crescent City lower down by the sea.



THE MISSISSIPPI RIVER AT MEMPHIS



1 Grand Opera House.
2 Lowenstein's Jean Pants Factory.
3 Cossitt Free Library.
4 Tennessee Brewery and other manufacturing plants.
5 Telephone Building.
6 Bank of Commerce Building.
7 Court Square and Main Street corner.
8 Lyceum Theater.
9 Front Street view.
10 H. Wetter Factory.

SOME ATTRACTIVE VIEWS OF MEMPHIS, TENNESSEE

HE MISSISSIPPI RIVER:

:n	7 Anchor Mills.
ſ Lumber District.	8 E. T. Bennett & Co.
Co.	9 Memphis Bending Co.

MILLS OF MEMPHIS, TENN.

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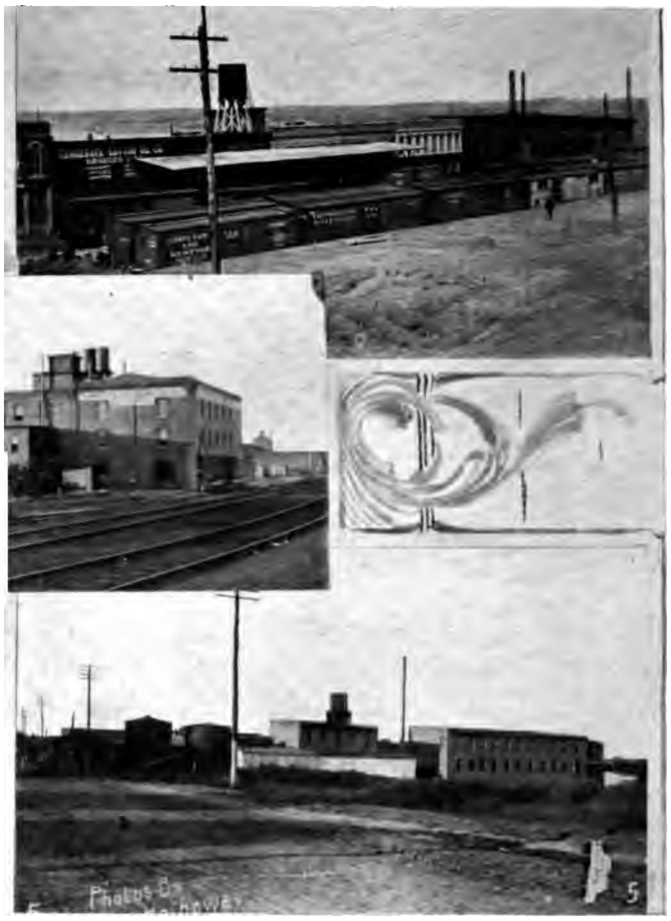
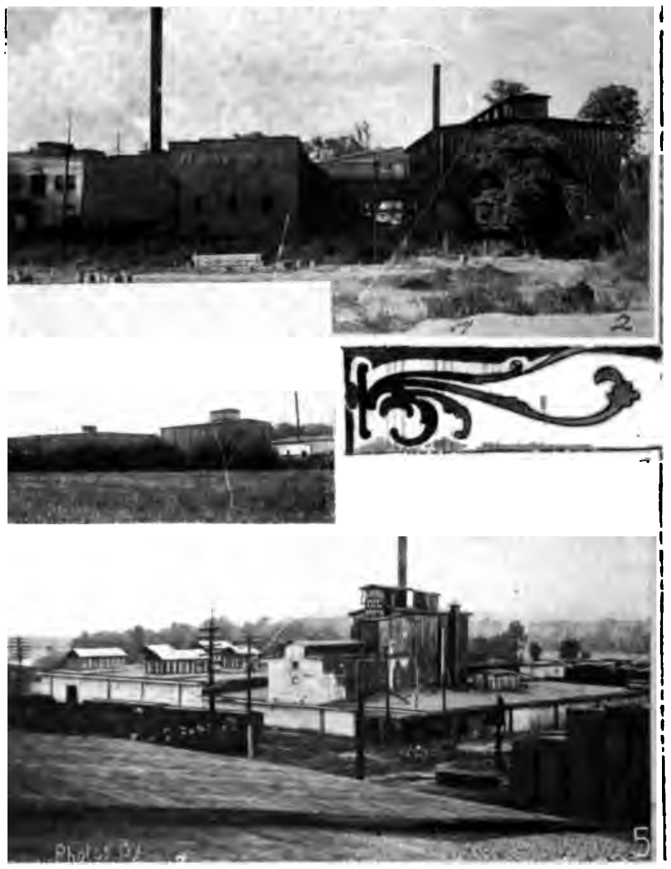
1 **Scatchard & Sons**
2 **Memphis Coffin Factory**
3 **E. T. Bennett & Co.**
4 **Memphis Stave Manufacturing Co.**
5 **Cochran Lumber Co. Box Factory**
6 **Alfee Heading Co.**
7 **Charles Sadder**
8 **R. J. Darnell**
9 **A**
10 **T**
11 **J**
12 **M**

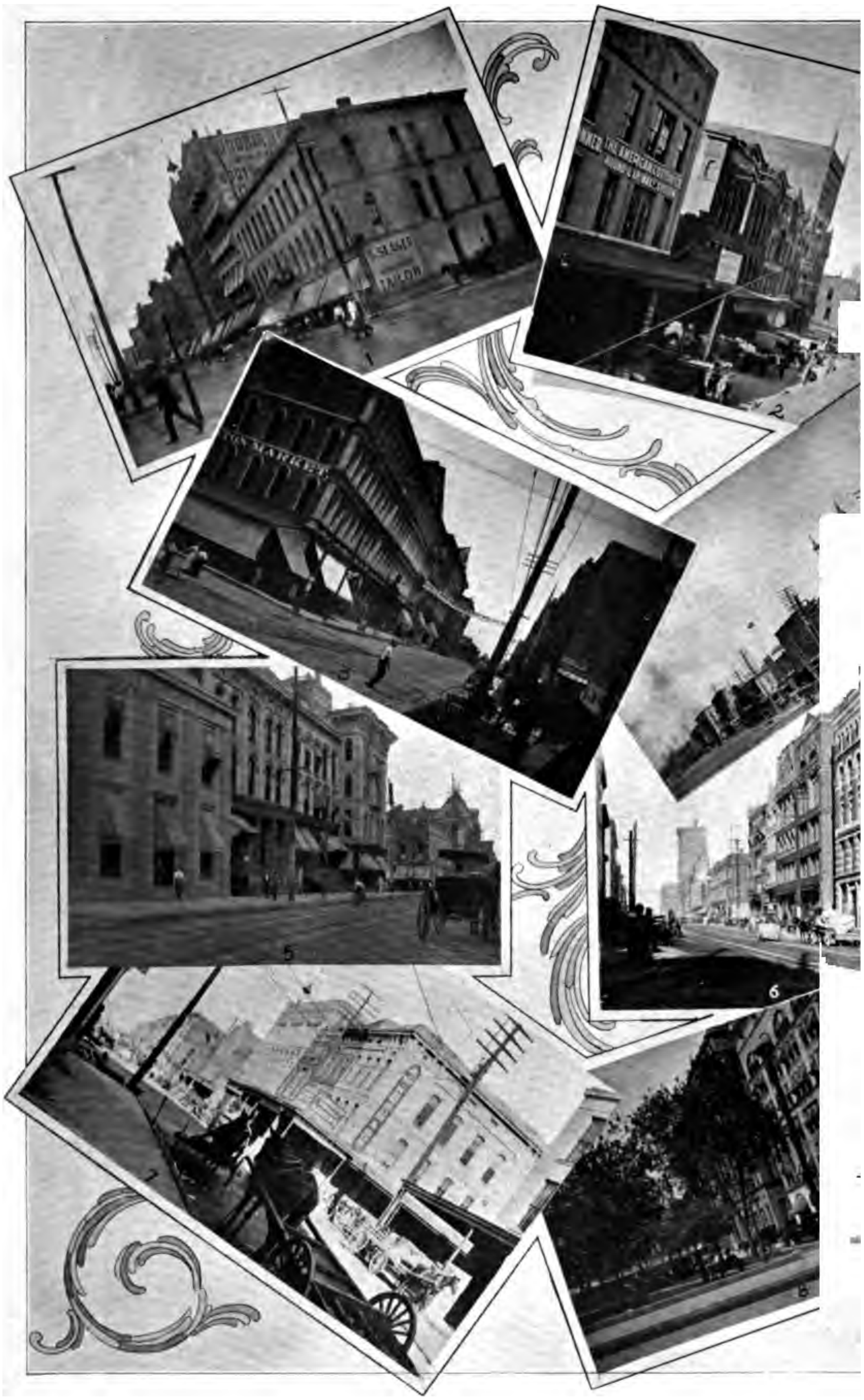


4 Richmond Cotton Oil Company
5 De Soto Cotton Oil Mills



mpany 3 The Southern Cotton Oil Company
5 Gayoso Oil Works

S OF MEMPHIS, TENN.



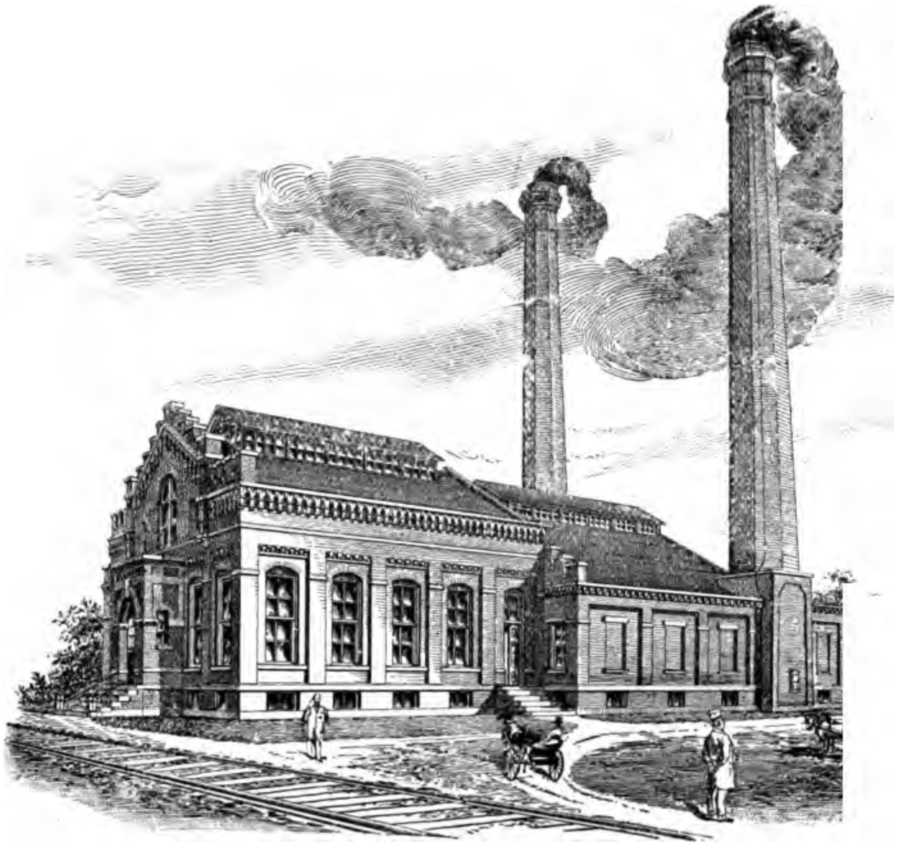
1, 3 Second Street, looking north.
5 Madison Street, looking east.
6 Main Street, looking north.
2, 4, 7 Views
8 Court Squar

VIEWS OF THE BUSINESS STREETS OF MEMPHIS

MEMPHIS COTTON EXCHANGE BUILDING

THE TENNESSEE CLUB

MEMPHIS IN GALA ATTIRE



ARTESIAN WATER WORKS, MEMPHIS

OF THE MISSISSIPPI RIVER:

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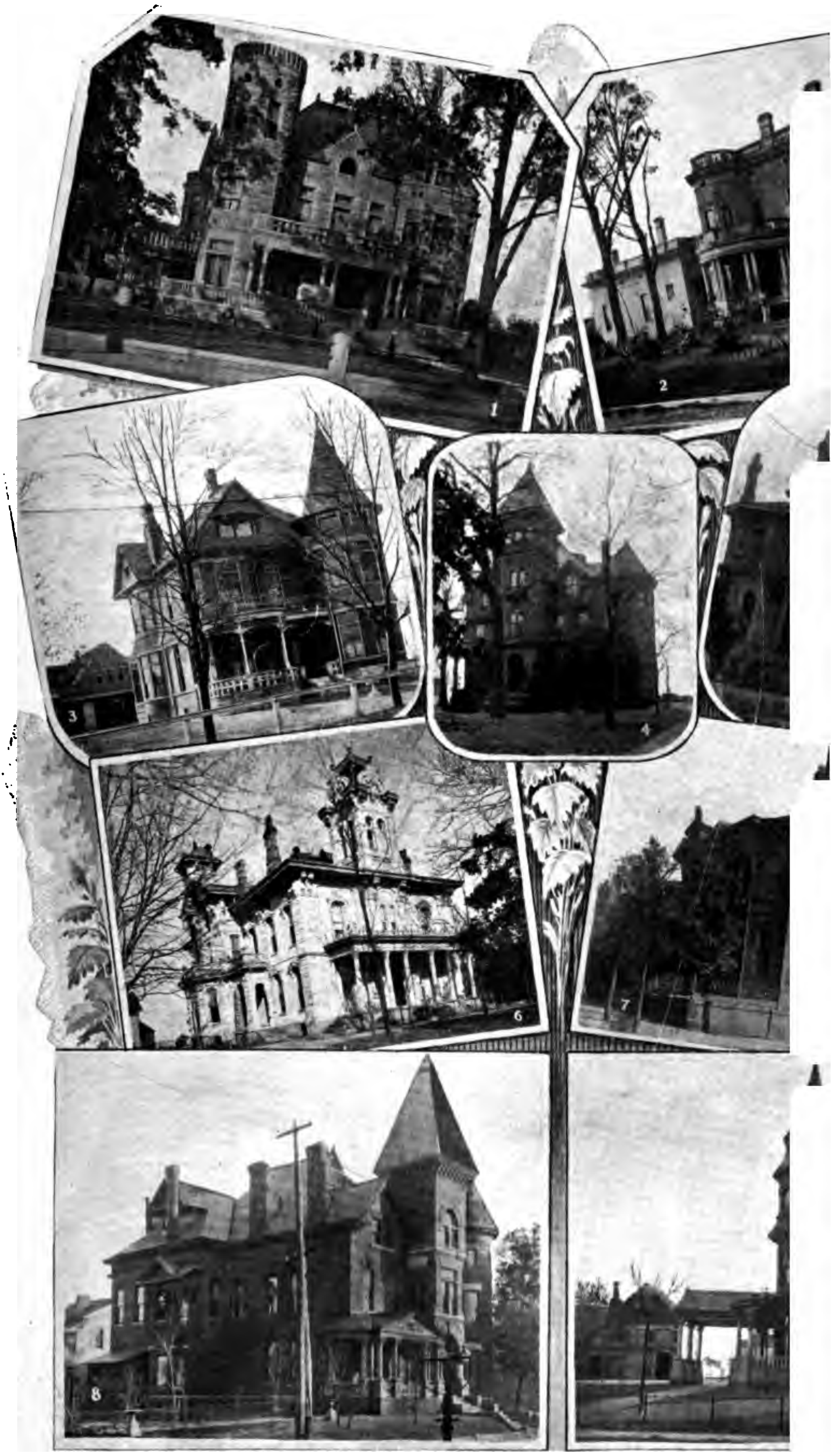
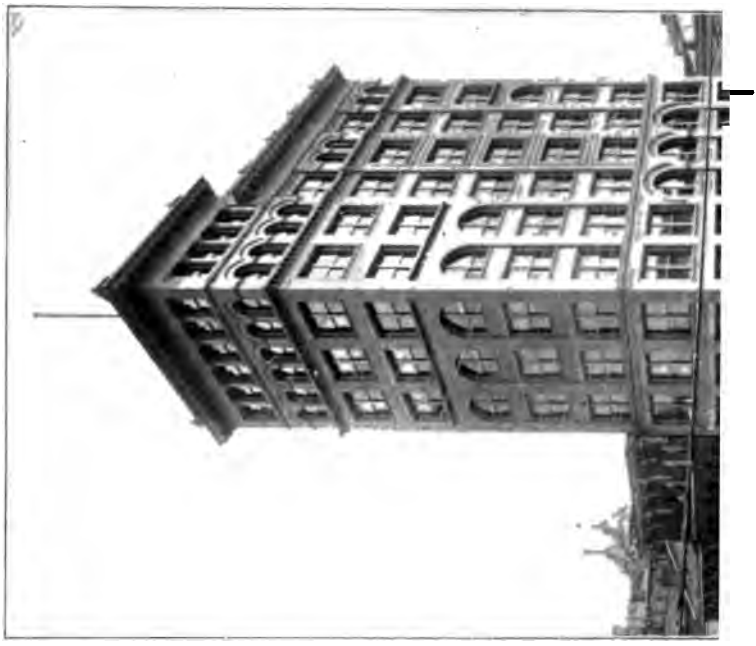
UILDINGS OF MEMPHIS, TENN.



SOME OF THE HANDSOME RESIDENCES OF MEMP

I LANDS OF THE MISSISSIPPI RIVER:

'Y RESIDENCES OF MEMPHIS, TENN.

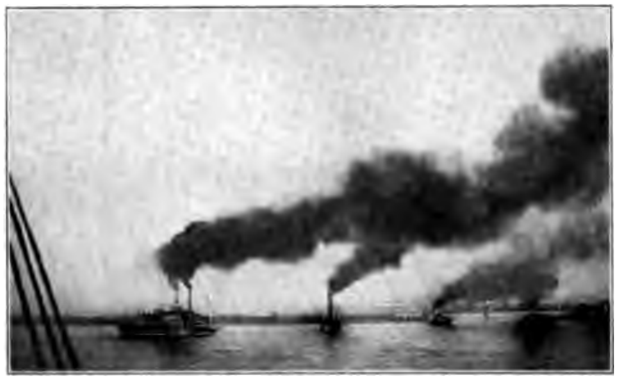


A BUSY DAY ON THE LEVEE

THE LARGEST SHIPMENT OF BOX MATERIAL ON RECORD

An Illinois Central train loaded in the hardwood lumber district of Memphis by one firm

U. S. STEAMER CONCORD IN MEMPHIS HARBOR



STEAMBOATS MEETING THE CONCORD AT MEMPHIS

COUNTIES WHOLLY AND IN PART ALLUVIAL, COMPOSING THE YAZOO-MISSISSIPPI DELTA, WITH AREA OF EACH AND ASSESSED VALUATION FOR 1880 AND 1890.

(For Population see Page 352.)

NOTE.—While population statistics for 1900 have been tabulated by the Census Bureau, the statistics of wealth, etc., have not. Comparison is therefore instituted between 1880 and 1890 dates. The increase in population as shown by the tables will serve to estimate the proportional growth of wealth.—*Ed.*

DE SOTO COUNTY

Total Assessed Valuation	**$2,600,000**
Area	**306,092 acres, ⅓ alluvial**

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" " " 1
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TALLAHA

Total Assessed Valuation 18
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More than d
Area....................

HOLM

Total Assessed Valuation 18
" " " 18
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YAZC

Total Assessed Valuation 18
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SUNFLC

Total Assessed Valuation 18
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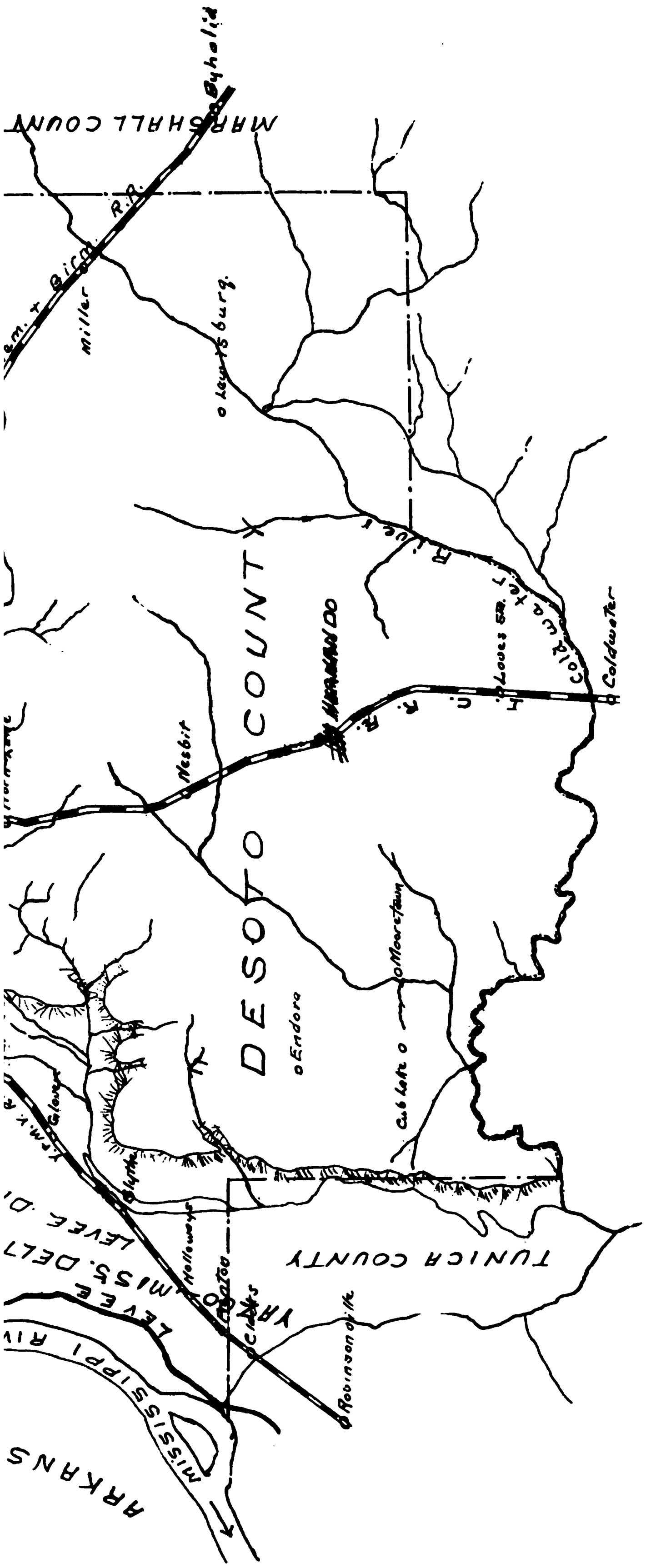
LA FL

Total Assessed Valuation 18
" " " 18
Area....................

RIAN LANDS OF THE MISSISSIPPI RIVER:



DESOTO COUNTY, MISSISSIPPI

For population see page 352; other statistics page 479.

MILL OF THE MISSISSIPPI COTTON OIL CO., CLARKSD

COTTON PICKING IN THE YAZOO-MISSISSIPPI D

NEW OIL MILL, TATE BROS., HOLLYWOOD,

ALLUVIAL LANDS IN MISSISSIPPI

The area of alluvial lands in the State of Mississippi, as shown by the authority which we are using (the calculations of the Mississippi River Commission as to overflow lands) is 6,926 square miles, or 4,432,640 acres. This does not include the alluvial lands of initial formation, which lie above the overflow, nor some which skirt the river in the lower portion of the State.

Practically all of the lands included in this computation lie in the famous Yazoo-Mississippi River Delta which heads a few miles south of Memphis and extends to Vicksburg, and lies wholly in the State of Mississippi.

The first settlement of the alluvial lands along the Mississippi River was begun in the early part of the century. Between 1830 and 1850 large areas were bought from the United States government along the river front in nearly all of the counties which border the Mississippi River and were cultivated largely with slave labor. Indeed, some of the finest plantations in the entire Southern country were opened up and developed in this section of the Mississippi River Valley between the years mentioned, in the fertile Yazoo-Mississippi delta, as well as many of the alluvial districts of the State further south in Wilkinson, Adams and Jefferson counties; so that prior to the late Civil war this was fast becoming the great cotton-producing center of the country.

During the war the levees were swept away, and for many years thereafter the delta was at the mercy of each recurring spring overflow. There was, however, much activity displayed in efforts to prevent these disasters, but withal many plantations were allowed to remain uncultivated, especially when the price of cotton begun to descend.

We might say that the upward tendency of improvement begun after the overflows of 1882, 1883 and 1884. For instance, in 1881, in the county of Bolivar, which is now one of the richest and best-developed in the delta, there were only 150,000 acres on the assessment rolls in the county, leaving nearly 400,000 acres of land forfeited, of which 200,000 acres were held by what was known as the "Liquidating Levee Board" as lands forfeited for levee taxes.

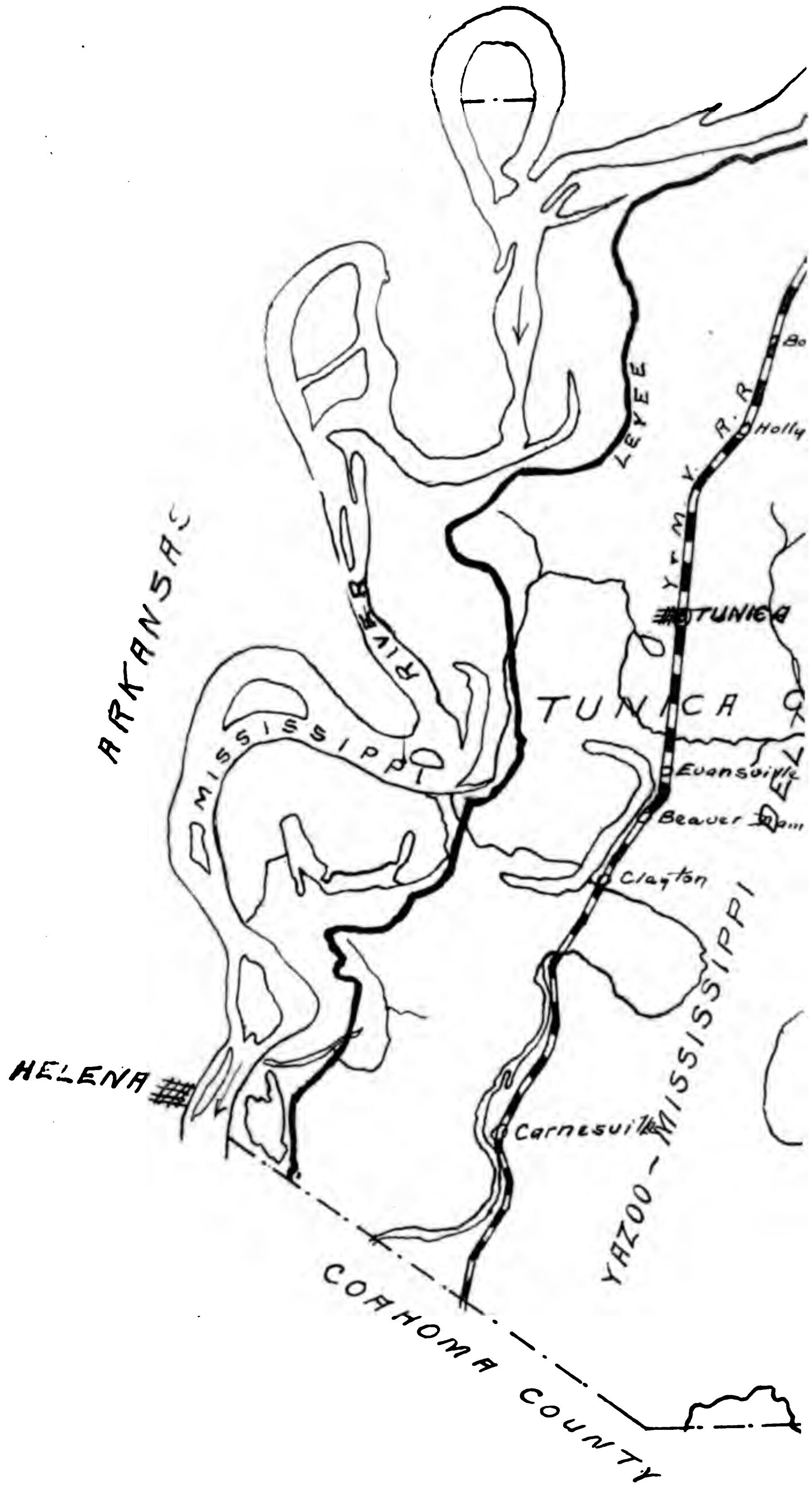
These levee taxes here mentioned consisted of an acreage tax and a bale tax as well; also, a direct ad valorem tax. The bale tax on cotton in the Yazoo-Mississippi delta has been as high as five dollars a bale at times, since the effort to reinstate the levee system was begun.

The first railroad built north and south through this delta was known as the Louisville, New Orleans & Texas railroad company, built during the years 1883 and 1884, from Memphis to Vicksburg, by R. T. Wilson. This is now called the Yazoo & Mississippi Valley road, and is a part of the great Illinois Central system, of which Stuyvesant Fish, of New York, is president, and James T. Harahan, of Chicago, second vice-president, in charge of the general operation of the road. In addition to the main line there was built, soon after the completion of the main line, what is known as the Riverside division, extending from Coahoma, in Coahoma county, to Rolling Fork, in Sharkey county, paralleling rather closely the Mississippi River as far as Greenville. Of late years considerable mileage has been added to this system in branch lines extending into nearly every county in the Yazoo-Mississippi Delta.

Following the building of the Y. & M. V. came the Georgia Pacific, entering the Delta a few miles west of Carrollton and traversing it, at its widest part, to Greenville on the Mississippi River. This railroad with a branch to Webbs, is now a part of the Great Southern Railway and is the coal carrying line which connects the rich coal fields of Alabama with the Mississippi River. At Greenville, its western terminus, are located facilities for transfer of coal to barges. (See Greenville.)

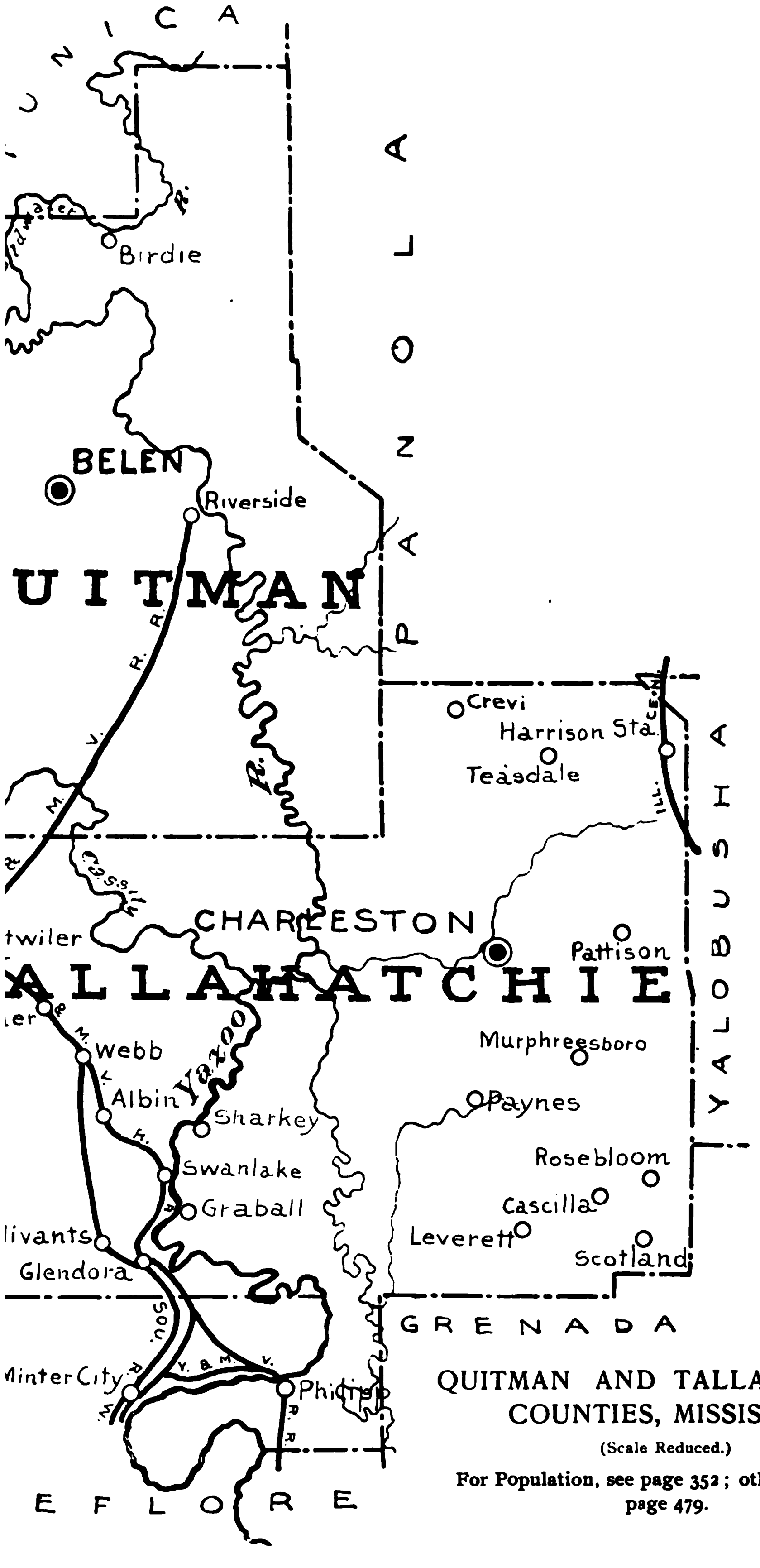
In the article furnished by C. H. West, chief engineer of the Mississippi Levee district, embracing the counties of Bolivar, Washington, Sharkey and Issaquena, and in the article furnished from the report of the chief engineer of the Yazoo-Mississippi Levee board, Major T. G. Dabney, are given statements regarding the progress of levee building in these sections, and it is unnecessary to recapitulate these facts.

As before mentioned, in 1881, 400,000 acres of land in Bolivar county had become forfeited, and were not on the lists as taxable property. In 1900 there is only about 8,000 acres of land claimed or held by the State, and not taxable. There are more than 400,000 acres owned and held by individuals and citizens, and over 225,000 acres of cleared and improved lands. This will give some



TUNICA COUNTY, MISSISSIPPI

For population see page 352; other statistics page 479.



QUITMAN AND TALLAHATCHIE COUNTIES, MISSISSIPPI

(Scale Reduced.)

For Population, see page 352; other statistics, page 479.

idea of the conditions which have prevailed, and the improvement which has taken place in this county, which is a criterion to the general progress of the Delta.

Washington county, and the river along the Issaquena front, were even earlier in their settlement than Bolivar, and the same conditions existed as mentioned in the description of Bolivar. By 1860 it had grown to be a veritable principality in the beauty of its broad, highly-cultivated fields, palatial homes and magnificent plantations. Refinement and hospitality characterized the planter. Indeed, here was to be found Southern hospitality and Southern culture in its highest development.

There is an unusually large quantity of what is known as highlands, such as border the lakes, (formerly bends of the Mississippi River, which were made into lakes by cut-offs at different times by the river) and on the interior streams and rivers. Two of the most beautiful lakes in the entire Mississippi Valley, Lakes Lee and Washington, are in this county. Back from the river are the Bogue Phalia, the Deer Creek, the Yazoo River, and several other streams along the banks of which abound these highlands, the soil of which is of a light sandy variety, easily cultivated, and very fertile.

While Washington county is considered one of the older counties, its advance has been almost phenomenal within the last twenty years. In 1880 the population was 25,367. The census of 1900 shows a population of 49,216. A more wonderful exhibit of its growth may be taken from the reports furnished me by the courtesy of Major W. E. Montgomery, Secretary of the Board of Mississippi Levee Commissioners, which show that Washington county paid levee taxes on 30,362 bales of cotton in 1880, and on 90,423 bales in 1897. Thus in seventeen years this county has increased its production of cotton over 200 per cent. In this connection it may be mentioned that Sharkey county has increased from 10,682 bales in 1880, to 29,884 bales, or almost the same per cent of increase.

Bolivar county has increased from 27,584 bales of the earlier date, to 53,200 bales in 1897, or nearly double.

Isaquena county from 18,801 bales to 21,119 bales. The explanation for the smallness of the increase in Isaquena is that it was almost as fully

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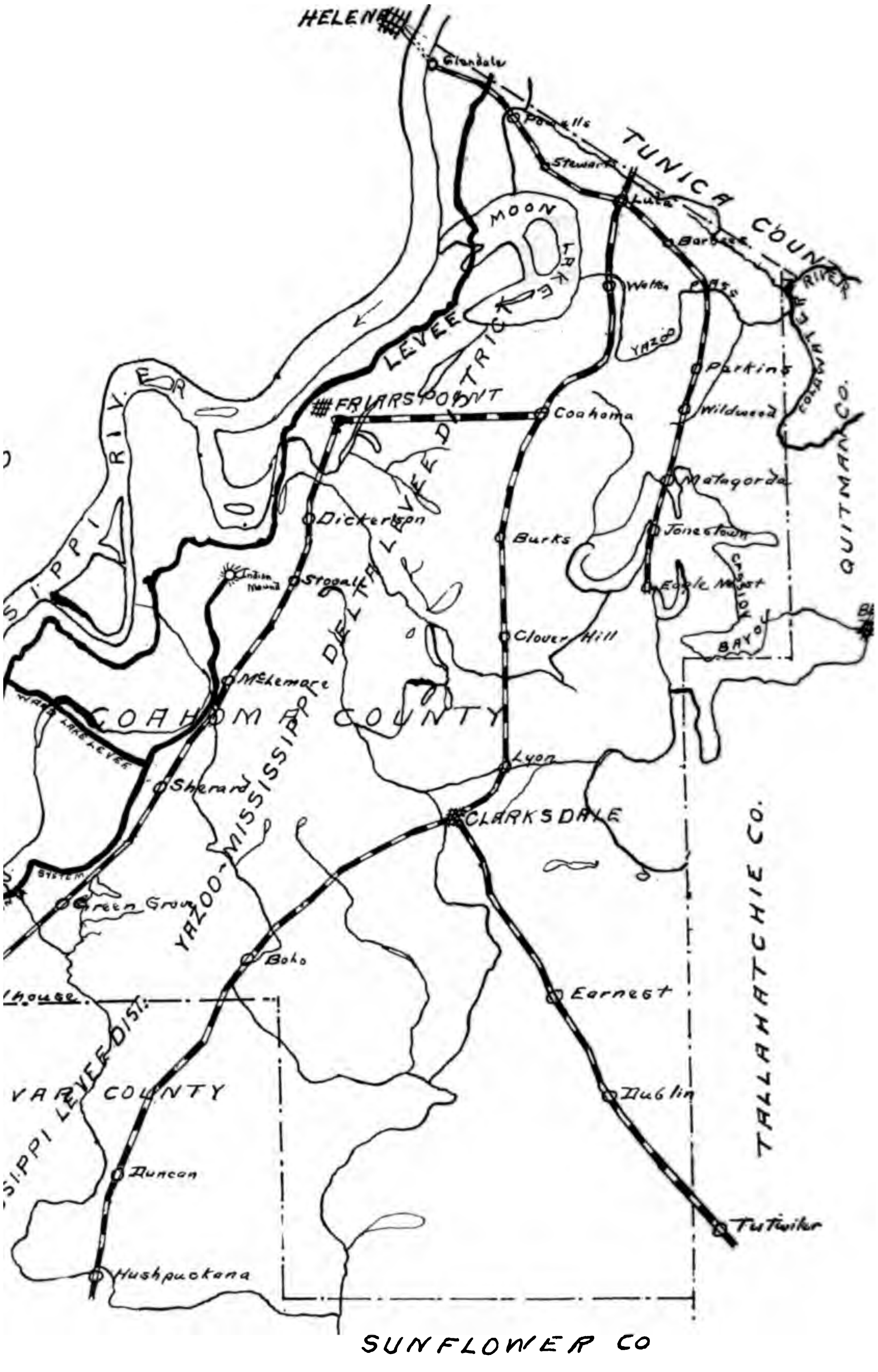
RIPARIAN LANDS OF THE MISSISSIPPI RIVER:



OUNTY, MISSISSIPPI

e page 352; other statistics
page 479.

COURT HOUSE, CLARK

PLANTERS BANK, CLARKSDALE, MISS.

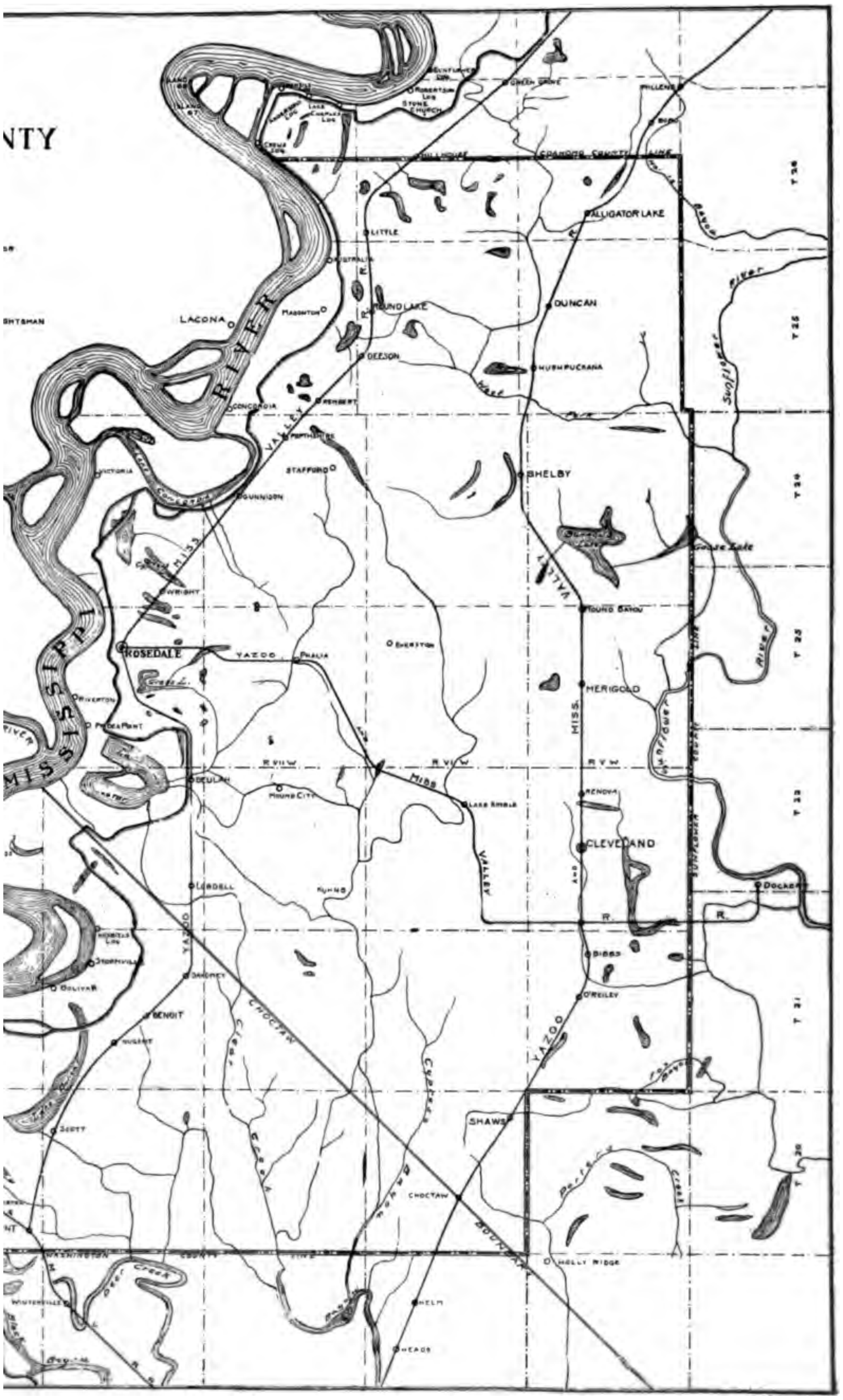
RESIDENCE ON DAHOMEY PLANTATION

GENERAL VIEW OF THE CULTIVATION OF DAHOMEY, THE LARGES

CULTIVATING DAHOME

PLANTATION IN THE WORLD, BOLIVAR COUNTY, MISSISSIPPI

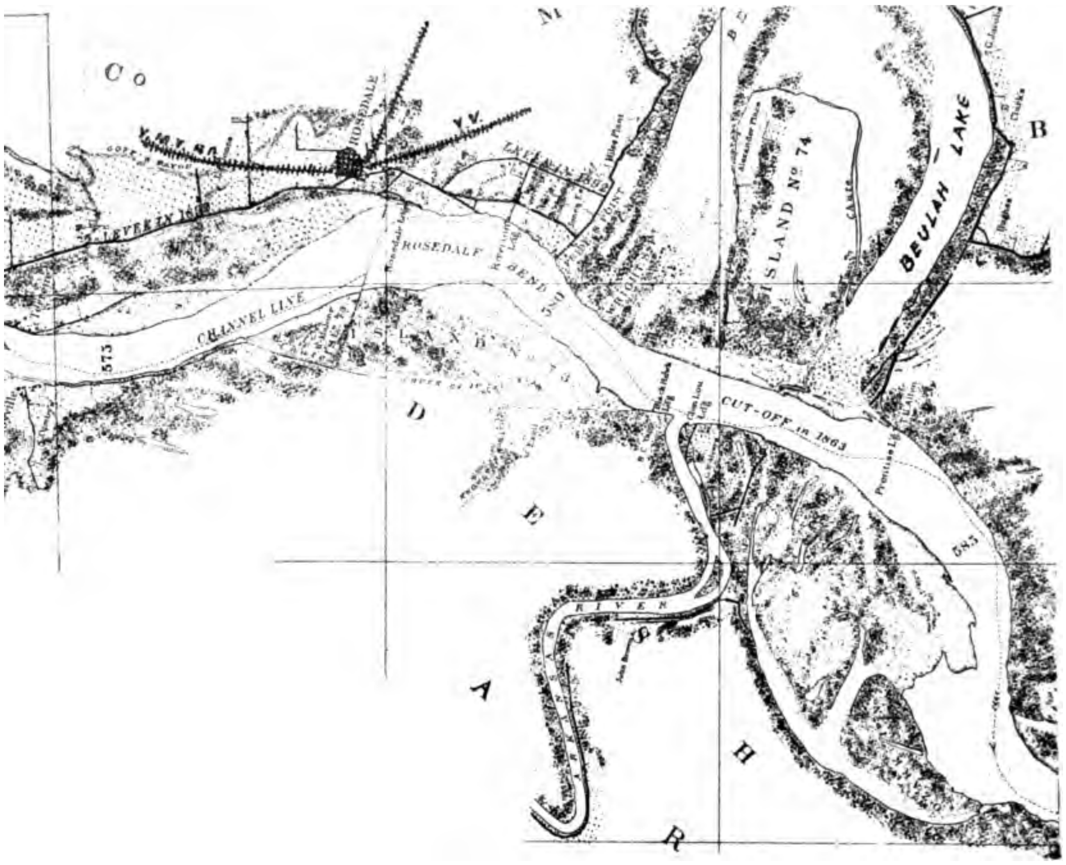
RIPARIAN LANDS OF THE MISSISSIPPI RIVER:



For population, see page 352; other statistics, page 479.

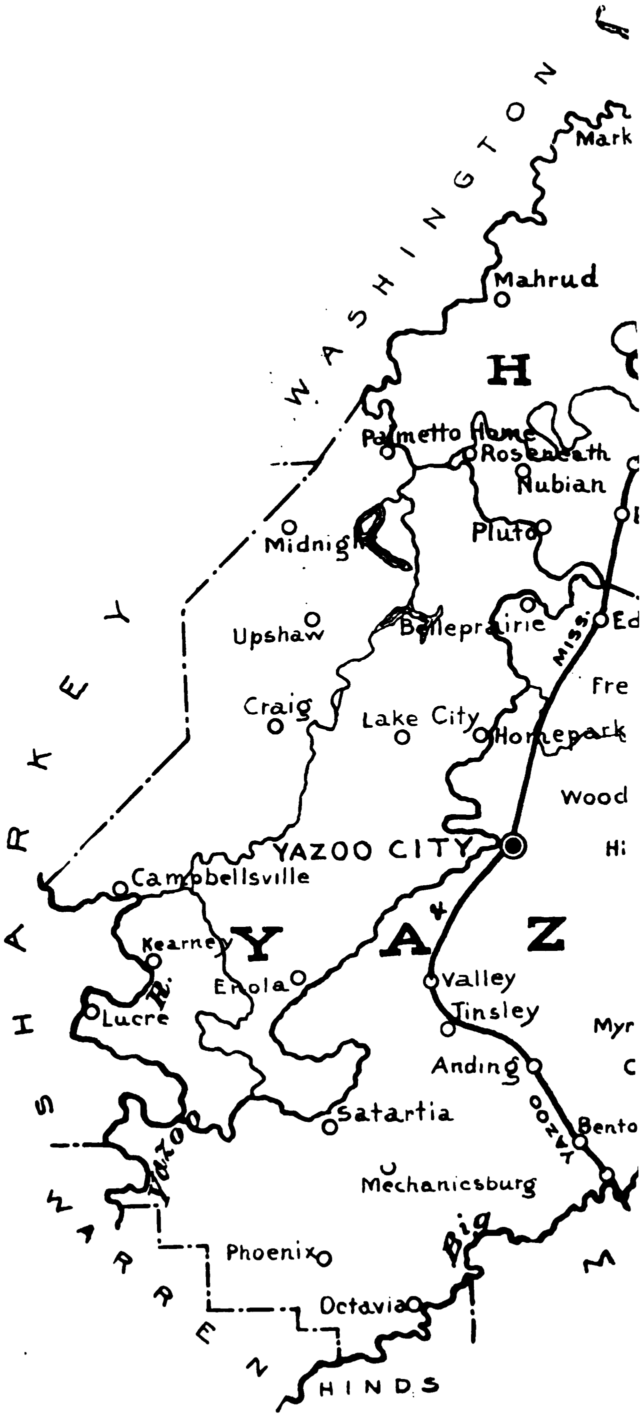
STOVALL, MISS.

RIPARIAN LANDS OF THE MISSISSIPPI RIVER:



RIVER AT ROSEDALE, MISS., SHOWING THE MOUTHS OF THE ARKANSAS AND WHITE RIVERS

COURT HOUSE, ROSEDALE, MISS.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Midnight
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Ed
MISS
Fre
Craig
Lake City
Homepark
Wood
YAZOO CITY
Hi
Campbellsville
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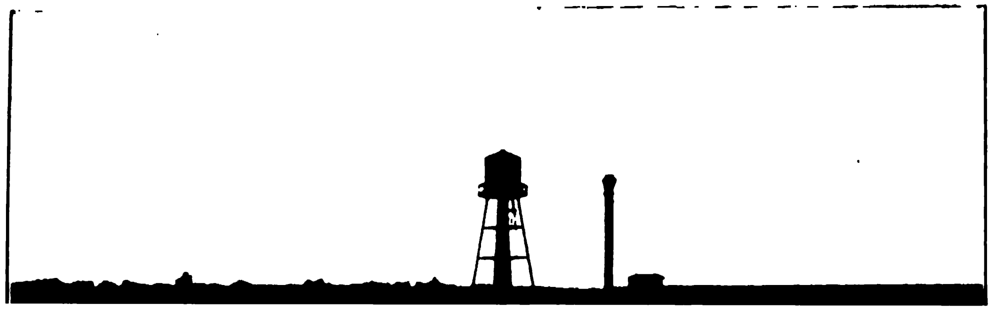

PRODUCERS CO.'S OIL MILL, YAZOO CITY

CITIZENS' OPERA HOUSE, YAZOO CITY

OIL MILL OF THE MISSISSIPPI COTTON OIL CO., YAZOO CITY

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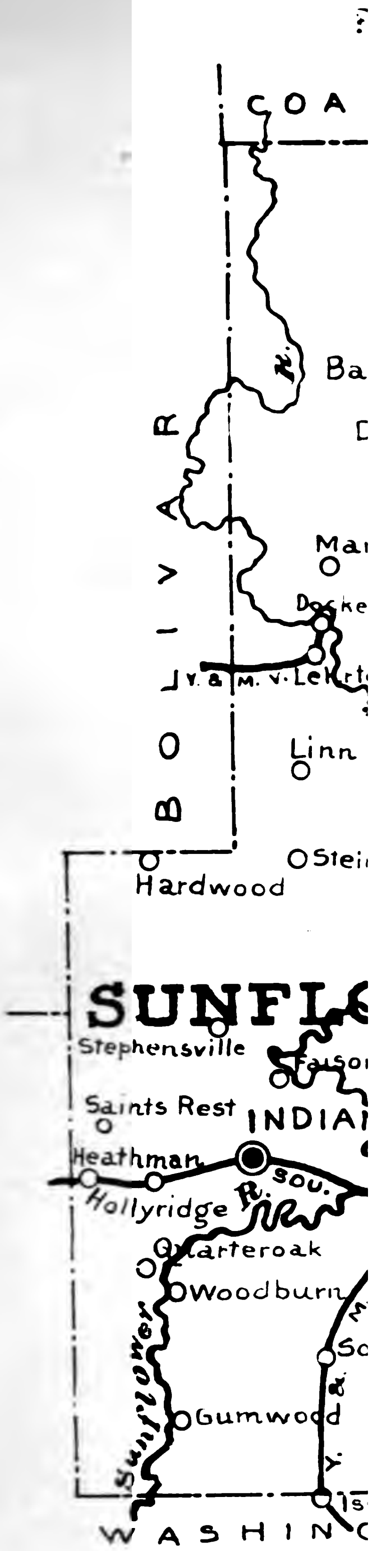

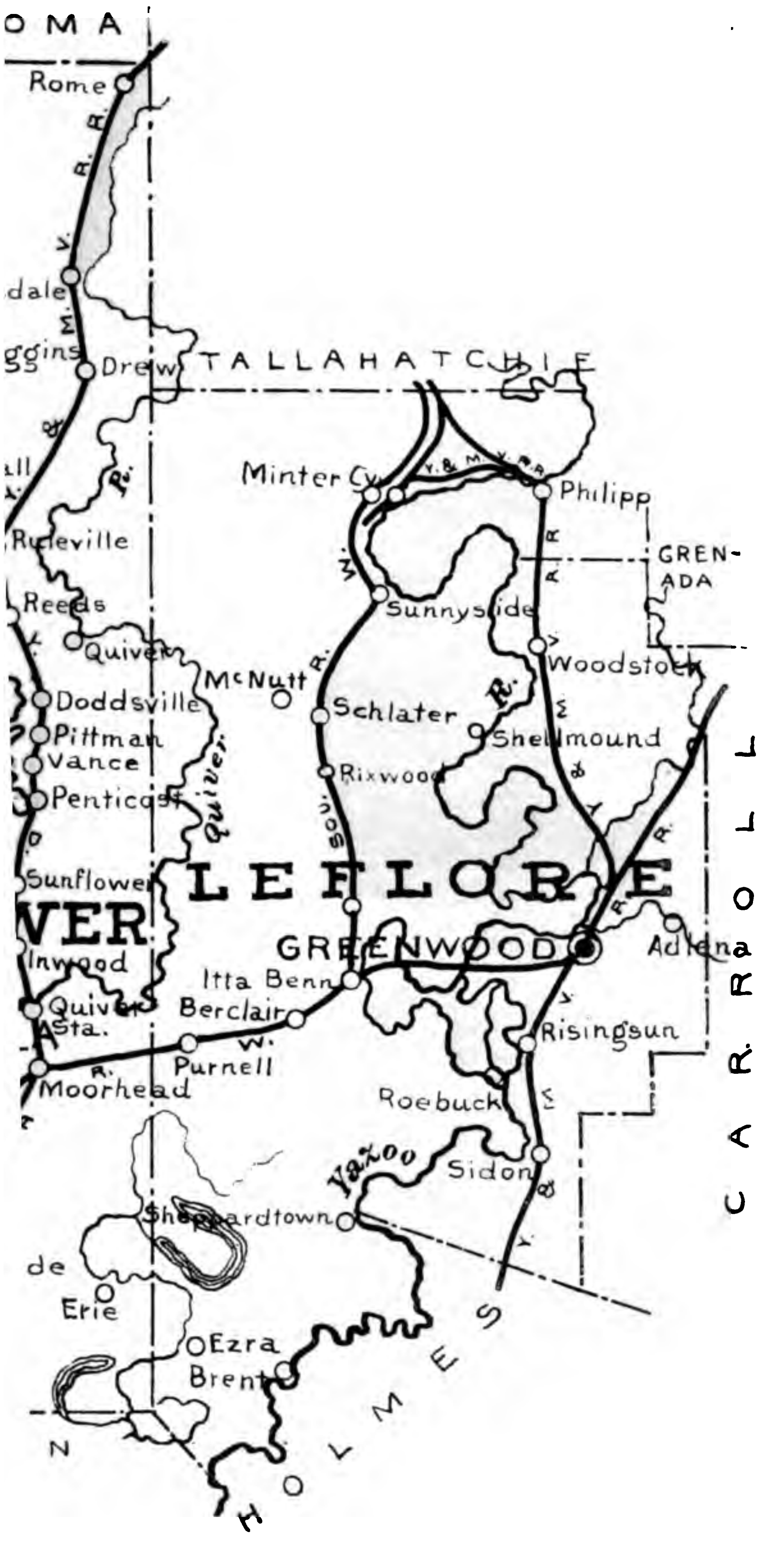

SUNFLOWER AND LA FLORE COUNTIES, MISSISSIPPI

(Scale Reduced,

For population, see page 352; other statistics page 479.

its presence. In those portions of the Delta
the lands have been opened for many yea
which lie along the lakes and rivers, an alm
tire absence of malaria is noticeable. R
there have been built artesian wells which
the drinking water, which heretofore cam
cisterns. These wells are contributing ver
to the health of the delta, and the day is not
tant when all the cities and towns and many
plantations will be supplied with crystal
from the bowels of the earth by means o
wells. The impression must not be made t
tern water is unhealthy, for, indeed, it is con
that rain water when caught at the proper s
and carefully shielded from any unfavorab
ditions, is the purest water in the world. T
trouble which people experience in this m
from lack of attention and care given to th
terns, and to the proper storing and protec
their water supply.

In connection with the map of each
which follows, is given its area and populati
ing the past two decades, which will be inte
to show the rapid increase in twenty years.

In an article on page 346, regarding the
chitto Levee district, is given some descrip
the alluvial lands which lie along the lower
of the State of Mississippi, and which are
tected at present by any adequate system of
In fact, nearly all are without any levee pro
whatever.

The value of lands in the Yazoo-Mis
Delta varies very largely; some of the fine
vated plantations can be had for from $35
an acre, while unimproved lands can be h
much cheaper. It may be said that the
value of land in this delta has increased at le
per cent within the last five years, and t
five years will probably show a greater i
As indicative of the price of timber lands i
quantities, the recent sale of 150,000 acres
section by the Yazoo & Mississippi Valle
road Company to Messrs. George T. Hou
Company, lumber dealers of Chicago, at a
mately $1,000,000, is reported in the publ
items. These are average timber lands, a
firm has bought them, it is presumed, lar
the timber which is on them, and that they
thrown upon the market as farm lands as
as they are denuded of the marketable

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This is simply one of many large sales which have taken place within the last few years and indicates a good price for these lands, and also that the country will be opened up to cultivation with great rapidity.

The Louisville, New Orleans & Texas Railway Company was granted a heavy subsidy in lands to aid the building of the railroad through the Delta. A large part of these lands have been sold, some to large investors who are placing sawmills in this section and cutting away some of the magnificent timber which abounds in such profusion; but much of it to small planters who are opening it up to cultivation.

Some of the back counties, in which list may be included Quitman, Sunflower, LaFlore, Sharkey, and the alluvial sections of Yazoo, Tallahatchie and Holmes, as well as eastern parts of Tunica, Coahoma, Bolivar and Washington, are of comparatively recent development; indeed, almost wholly so, except some portions lying on the high ridges along the banks of the rivers and bayous, which are always higher than the lands known as "buck shot" that lie away from the streams.

As an indication of the development in these counties attention is called to the statistics of population which appear at the head of this article, and the assessed valuations of many of the counties.

NATCHEZ, MISSISSIPPI

The city of Natchez is beautifully situated on the bluffs overlooking the Mississippi River, and the fertile alluvial basin lying in the State of Louisiana at nearly its widest part in North Louisiana. It had a population in 1880 of 7,058, which had increased in 1890 to 10,101. The last census gives it a still larger increase.

The railway communication enjoyed by Natchez is excellent. Connecting with the alluvial districts in Louisiana are two railroads; one terminating at Bastrop, which traverses or borders the alluvial sections of the State for nearly the entire distance. Another wholly in the alluvial districts extends to Trinity. These roads have their termini at Vidalia, which is situated on the opposite side of the river from Natchez.

On the east, Natchez is connected by the Natchez & Jackson division of the Y. & M. V. R. R. with Jackson, Mississippi, where it meets the Queen & Crescent and the Illinois Central. At

Harriston, 25 miles out, this division c
the main line of the Y. & M. V. R. I
south, thus giving quick communicat
parts of the country. The Mississip
course, affords navigation all the year
enterprising people of Natchez have tl
tems of steamboat transportation line:
and south, which do a large business a
perous. At Natchez is located two of tl
ton mills in the entire Southwest. Tl
solidly built brick buildings of large si
equipped with the latest machinery.
are both paying good dividends, and a
Natchez people.

Natchez being an old city, and a v
one in ante bellum times, has many fi
built by the wealthy planters of tho:
also many which have been built sinc
keeping with her gradual improvemer
tion and in business success. In all t
adjuncts to the well-regulated city, s
works, ice factories, compresses, cott
etc., Natchez is fully abreast of any ci
in the Valley.

Commercially, Natchez occupies a v
position. She enjoys a large wholesal
the interior both east and west of th
through her steamboat lines, from bot
below along the river. Her comme
both wholesale and retail, are numero
abundant capital. One of the largest
ing drug firms in the Southwest is do
The banking facilities of the town a
good, and the deposits in the banks ar
city in the Mississippi Valley is more
the development of the alluvial lands tl
not only those of Louisiana, with w
quick rail communication, but also on
ippi side in what is known as the Hom
District, which extends as far sout
Sara.

VICKSBURG, MISSISSIP

Were this an historical narrative
cursory view of present conditions, it
great deal of space to describe many
have made Vicksburg famous. But o
not of the past but of the present and

Vicksburg in 1880 had a populati
The last census gives it 14,834. This i

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in population has come through industrial enterprises in which Vicksburg excels. Unfortunately the overflows which have swept the Mississippi Valley have done their greatest damage in the neighborhood of Vicksburg on the Louisiana side, from which this city reasonably expects to get a large portion of its trade. These disasters have prevented the development of this rich alluvial section, consequently have prevented a natural increase in the population of Vicksburg which a development in this section would have brought about. That is, Vicksburg would have had a larger population than she now has if the farming trade had increased with the same rapidity as the manufacturing. Another disadvantage under which Vicksburg has been compelled to labor is its distance from the river in times of ordinary and low stages of water. The cut-off, through what is known as the Grant Canal, in 1876 removed the business portion of Vicksburg fully two or three miles from the river. In times of high water boats can land at the old wharves through Centennial Lake, which was the former bed of the river. Some years ago General T. C. Catchings, the able member of Congress representing the congressional district in which Vicksburg is situated, secured from Congress appropriate legislation looking to the turning of Yazoo River, which empties into the Mississippi River only a few miles above Vicksburg, into Centennial Lake, thence to the Mississippi some miles below its present mouth. This will afford all of the facilities which were lost by the cut-off in 1876.

Accompanying this article is found a drawing showing the route of the Yazoo River through Centennial Lake. This improvement is rapidly progressing to completion and will be one of the engineering wonders of the United States, as the Yazoo is a river of considerable importance, and has a large volume of discharge. In fact, it is rated, next to the Red and Arkansas Rivers, as one of the best and largest affluents of the Mississippi in the South. With the building of permanent levees beyond the danger of possible overflow, and with the natural improvement which will take place in the Tensas basin therefrom, Vicksburg will enjoy a large traffic from that section of the country.

In both the commercial and industrial lines Vicksburg is unusually strong. Here are situated

Brunswi
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V. S. &
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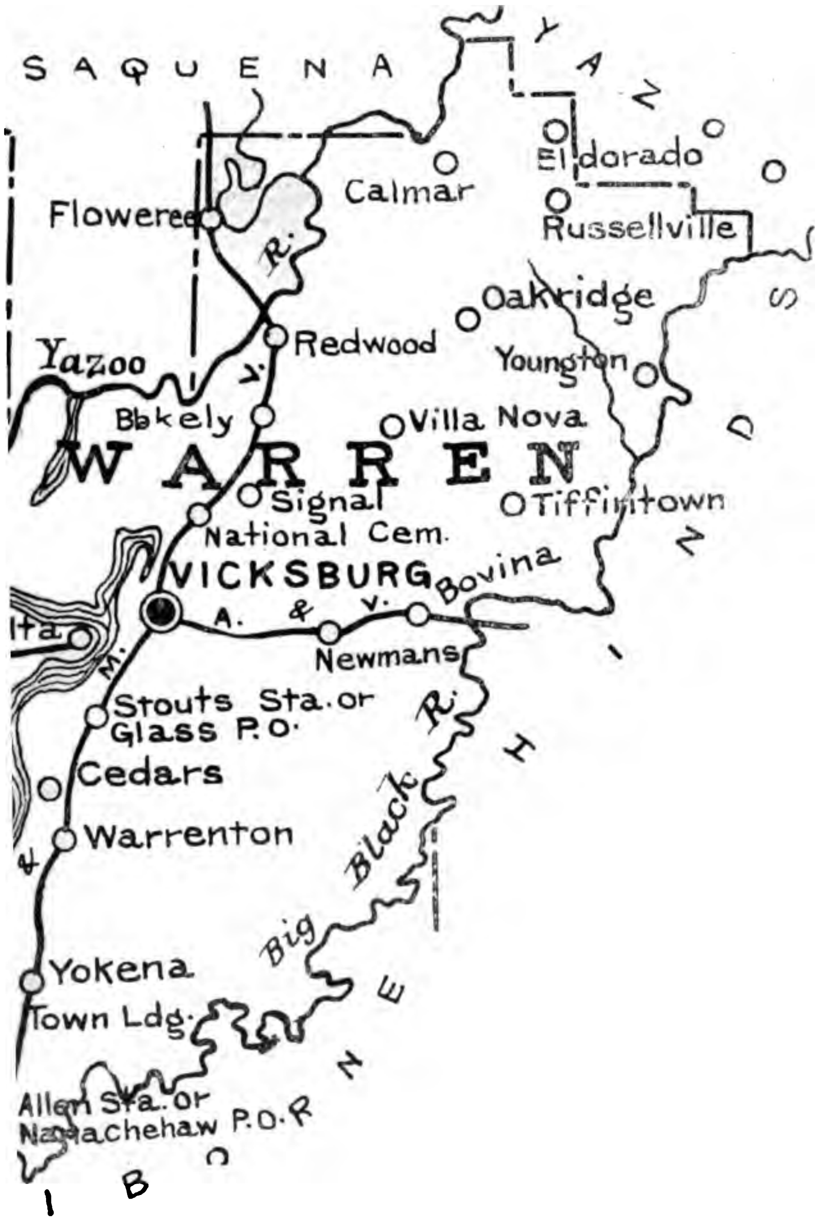
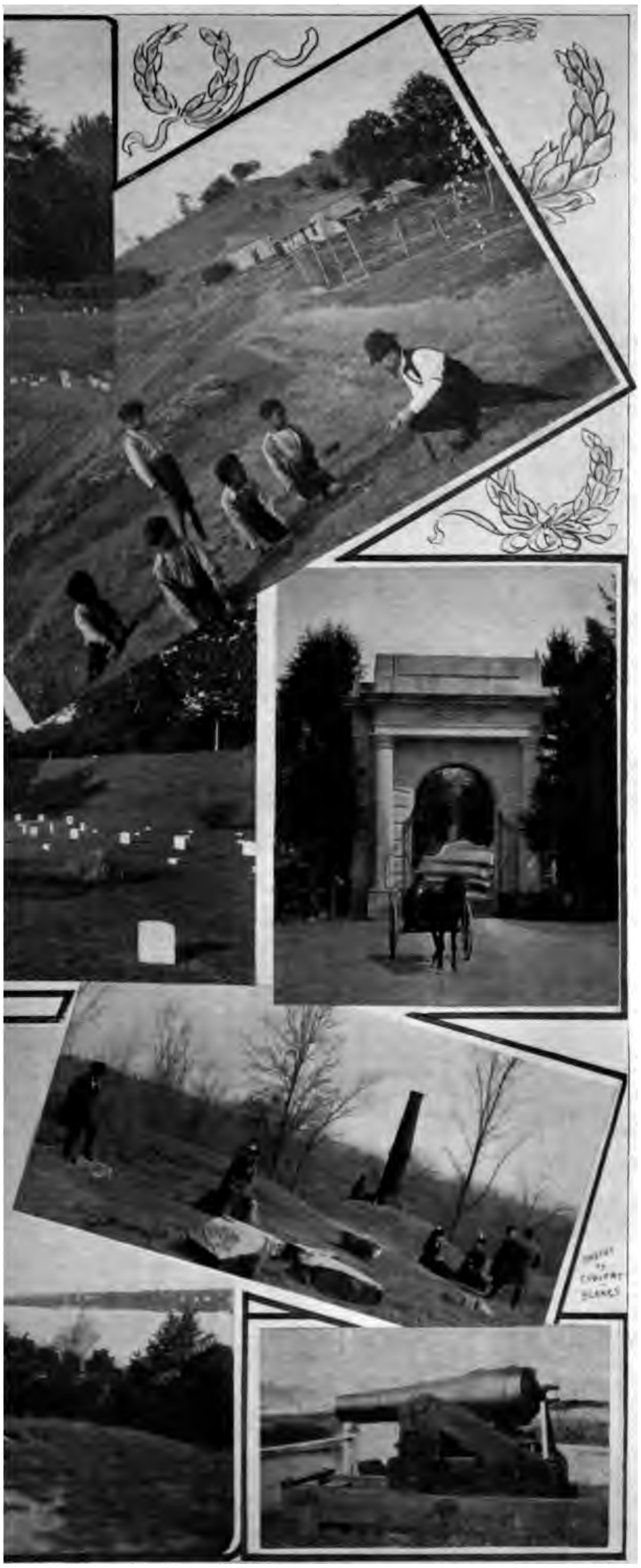
ROLLING FORK OIL MILLS



WARREN COUNTY, MISSISSIPPI

For population, see page 352.

VIEWS OF TH



AL CEMETERY, VICKSBURG, MISS.

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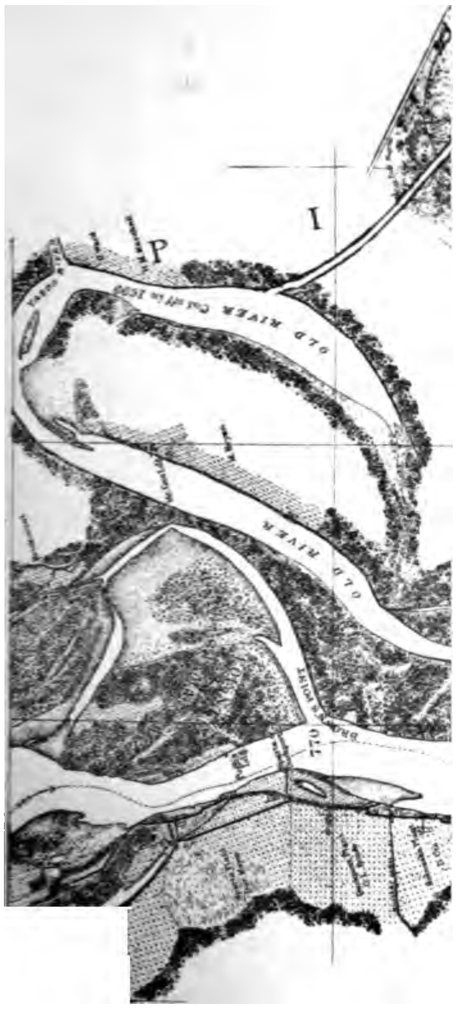

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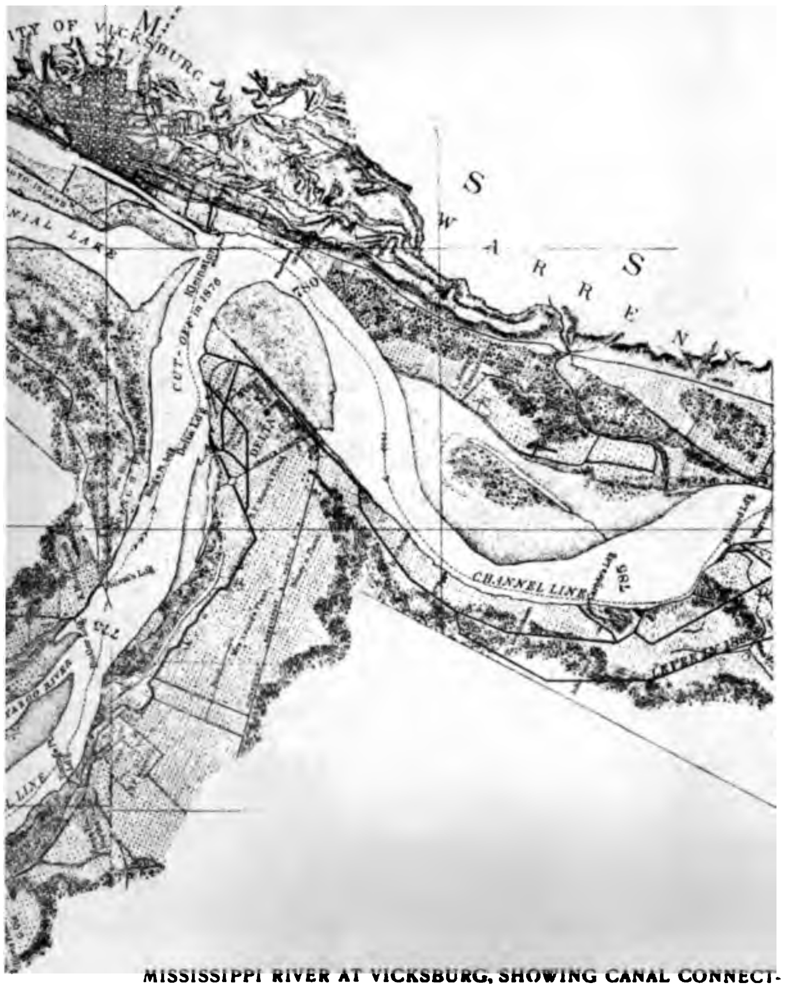
NEW PIAZZA HOTEL



MISSISSIPPI RIVER AT VICKSBURG, SHOWING CANAL CONNECTING OLD RIVER, AND THROUGH IT, YAZOO RIVER, WITH CENTENNIAL LAKE.

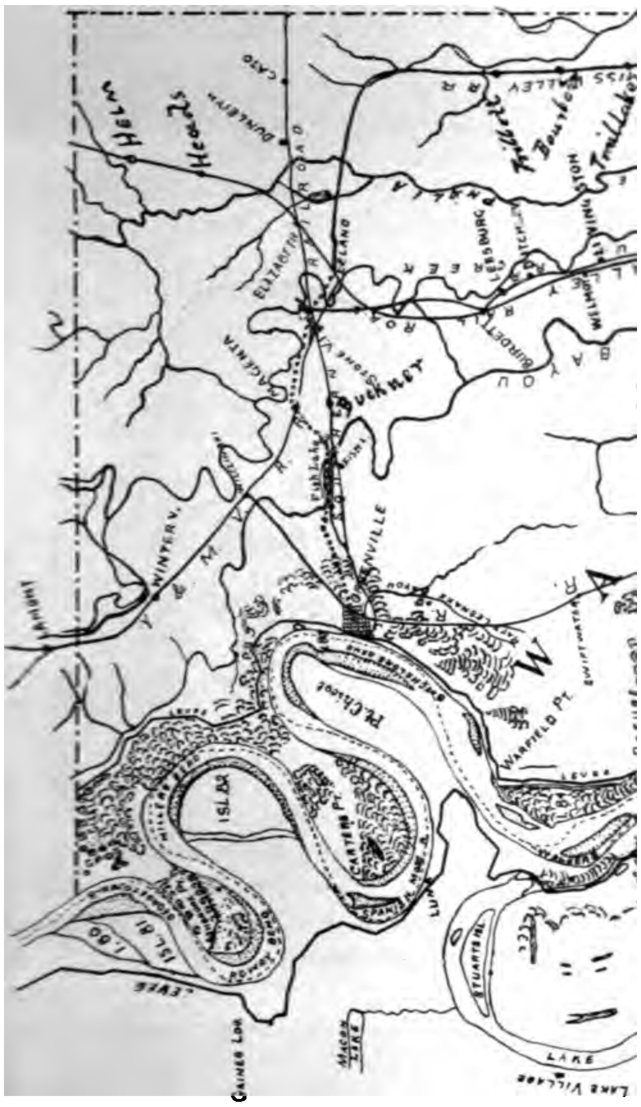
AN ANTE-BELLUM SOUTHERN H

AN

IDEAL HOME AT PETTIT, MISS.

A HANDSOME RESIDENCE, NITTA YUMA, MISS.

IVE DELTA HOME, NITTA YUMA, MISS.


Helm
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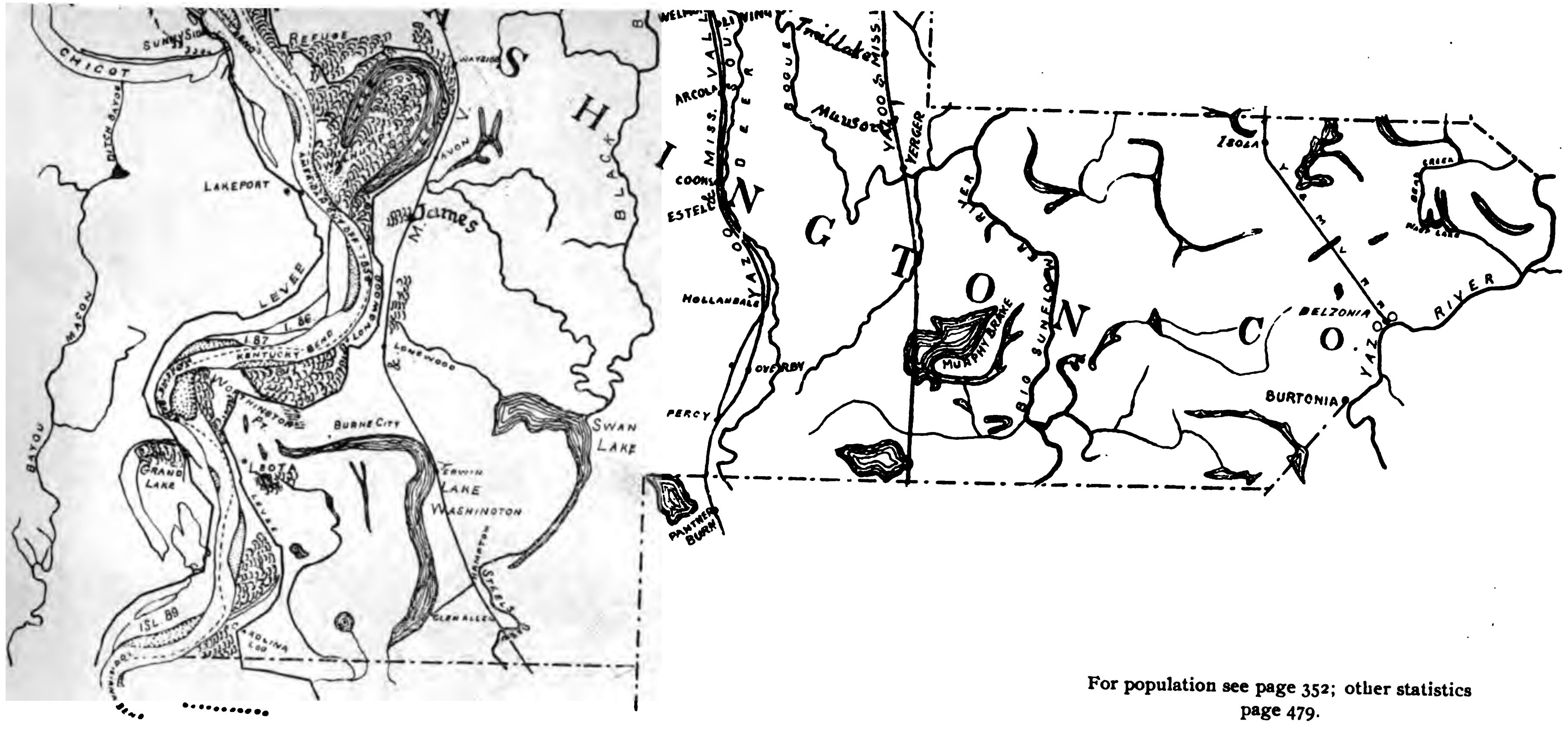
Dunleith
Cato
Elizabeth
Leland
Stoneville
Buckner
Valley
Burdette
Leesburg
Winterv.
Lamont
Pt. Chicot
Warfield Pt.
Carters Pt.
Isl. 82
Isl. 81
Isl. 80
Stuarts Isl.
Lake Village
Gaines Ldg.
Macon Lake
Levee
Bayou
Railroad
Greenville



For population see page 352; other statistics page 479.

some of the finest oil mills and luml
found on the Mississippi River. I
merchants do a large business both
boat, while the retailers secure a go
that portion of the population engag
enterprises, from a very fertile hill
lies contiguous to it, as well as fro
tions of the rich bottoms.

Vicksburg has exceptional banl
All of her banks are financially stro
are several. These afford ample ca
the heavy crops which seek Vicksbu
let. This city has two commercial
the Cotton Exchange and the M
change, each of which has a large
Recently Vicksburg has undertak
hensive system of sewerage, and on
electric street car services has bee
about two or three years. In conne
building of this road was opened u
the city.

Vicksburg in the coming years
known to distant sections througl
cemetery, and the national park, w
has decreed shall be established h
turesque hills which lie around V
which were the scene of the sanguir
the last war, will be beautified and l
generations in memory of the gallai
American soldier on both sides—of t
in the trenches in defending the g
well as of those who made the her
the impregnable line of breastwork
of frowning cannon.

YAZOO CITY, MISSISS

Yazoo City is the county seat of
which is one of the wealthiest in
next to the largest.

It is built on the bluffs overlo
Yazoo-Mississippi Delta, in which li
the county of Yazoo.

The population of Yazoo City i
542; in 1890, 3,358, and in 1900 it
rapid increase, having 4,994 inhabit

It is one of the largest cotton
State, and is doing a constantly i
ness.

The Yazoo River is navigable
around, and has a regular packet
[illegible] at this place.

It has fine natural drainage, and also a modern underground sewerage system. Artesian water is used exclusively.

The city has three banks, the total capital stock being $200,000: The First National Bank with a capital stock and surplus of $60,000, the Bank of Yazoo City with a capital stock and surplus of $110,000, and the Commercial State Bank with a capital and surplus of $60,000.

It has the usual complement of wholesale and retail business houses and many industrial enterprises.

A library endowed by Mrs. Fanny J. Ricks, widow of the late General B. S. Ricks, is one of the features of the city; also, the $35,000 opera house.

There are six miles of paved streets, electric lights and water works.

A cotton mill with a capital of $100,000 is planned. The site has already been bought, and the factory will soon be a reality.

There are two oil mills; one of the mills of the Mississippi Cotton Oil Company is situated here, and the Producers' company also have a mill.

The People's Warehouse & Compress Co. have one of the largest warehouses in the South. The concern is capitalized at $165,000, all owned by home people. It has a storage capacity of 32,000 bales of cotton.

Yazoo City has railway connection north and south by the Yazoo & Mississippi Valley Railway, and as before mentioned, is situated on the Yazoo River, which, with its affluents, have the full sweep of the western side of the great delta, and these give Yazoo City splendid facilities for the transaction of its present trade, and for an increase which must inevitably come.

Yazoo City is fully abreast of other places of like size and importance in churches and schools.

GREENWOOD, MISSISSIPPI

This is one of the most remarkable cities in the delta in its growth and in the growth of the industrial enterprises which largely support it.

In 1880 Greenwood had a population of 308, in 1890 of 1,055, and in 1890 its population is 3,026, showing a most remarkable increase for the past two decades.

It is situated on the banks of the Yazoo River, and has railway communication by both the Georgia Pacific division of the Southern Railway and a branch of the Yazoo & Mississippi Valley.

In 1896 its entire assessed va
357,494; in 1900 (in the space o
increase of assessed valuation ha
making the assessed valuation f
LaFlore nearly four millions of d

Greenwood has three banks; the
the Bank of Greenwood, each wit
tal, and the Bank of LaFlore with
It has several wholesale houses, co
oil mills, machine works and four
ies, electric lights, and stave facto
tory, hardwood and planing mills,
industrial enterprises.

A handsome school house is ne
at a total cost of $20,000. In ad
way facilities mentioned above, i
Tallahatchie, and Yallobusha Ri
well known, run through some of
sections of the State of Mississipp

This city has several fine churc
did well-equipped public school
the most attractive features of t
becoming common in the Delta,
artesian well water, which gushe
pressure, and is sufficient to sup
pipes, all the business houses and
city.

GREENVILLE, MISSI

Population 1880, 2,191; 1890,
642.

In the description of the allu
Yazoo-Mississippi Delta mentio
of the remarkable increase in p
county of Washington. Green
seat, has kept fully up with thi
county, perhaps exceeding it in
grown within the last twenty yea
village on the banks of the Missi
a small retail business, into one of
ous and growing cities of the de
politan in all respects. It has a
tem, affording abundantly the b
artesian water; a sewerage syste
to completion, a fire departmen
public school system. It has
houses that do a large business.
wholesale grocery house in the
ippi is at Greenville. There are
six oil mills and three cotton c

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several sawmills of the latest design. This is the terminus in the alluvial valley of the Great Southern Railway system, which affords direct connection with the coal fields of Alabama. This company has a coal tipple at this place, and within the last five years has built up a splendid coal business down the Mississippi River, handling the Alabama coal. The exact figures showing the amount of these shipments is not at hand, but it is very large and rapidly increasing. The Riverside division and two other branches of the Yazoo & Mississippi Valley enter Greenville. It is in direct connection with all parts of the Mississippi Valley by railway communication, and is admirably situated for the extension of its business.

There are several new industries either in course of erection or contemplated. A cordial invitation is extended to capitalists seeking location for any kind of industrial enterprises, either in cotton or wooden manufactures. A cotton mill is one of the enterprises which has assumed tangible shape, and will soon give this enterprising little city prestige in that direction.

CLARKSDALE, MISSISISSPPI

This city is one of the best examples of rapid growth caused by the development surrounding alluvial sections, and by the building of new railroads which largely center here. The 1880 census shows no such place as Clarksdale. The 1890 census gives it 781 inhabitants, and it was a busy and growing town then. The present census gives a population of 1,711 souls. Clarksdale is so situated that, by means of railroad branches, it commands an important strategic position in the great delta. The Y. & M. V. R. R. branches out from it in several directions, and a rapid increase in population, following the opening up of new plantations and new industries in all directions, must inevitably take place. At present it has cotton compresses, oil mills, woodworking industries, an ice factory, and other minor industries. It is one of the county seats of the large, rich county of Coahoma, and a fine court house adds to the beauty of the little city. Two sound, well-managed and successful banks afford ample capital for all purposes. This must develop into one of the largest cities of the delta. Its location and surroundings are such that improvement in this direction, which is now constantly going on, will naturally increase with even great keeping with the improvement and ing around it. It offers fine opport investor, manufacturer and business

Rosedale, one of the county seats, mills and soon-to-be cotton oil mil the other county seat, with its sev enterprises and its growing trade wi of the rich country which is being op nison, Shelby, Shaws, Benoit and oth the thriving towns of Bolivar coun

In Coahoma county, besides Clark mention has been made, Friars P county seat, and at present dividi with Clarksdale, is the oldest and town in the county. It has a ban and many handsome residences.

Other towns are Lula, Jonestow ons, Coahoma, all showing an upw growth in keeping with the openi homes, the increase in the lumber erection of woodworking plants county, lying north of Coahoma,

REGISTERED CATTLE AS THEY CAME

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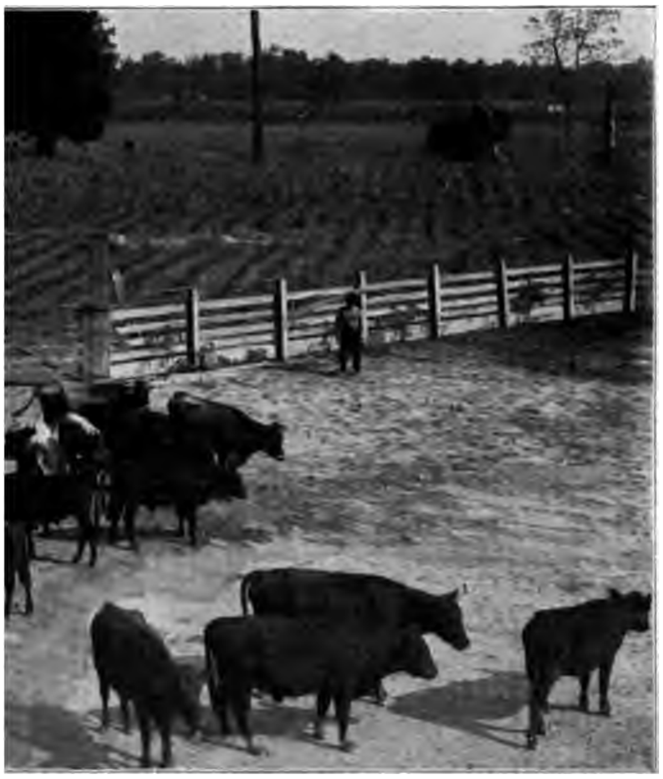
show much growth and business activity: Tunica, which has several mills; Hollywood, where is situated the fine oil mill of Tate Brothers, of Memphis; Robinsonville and other places. In the counties further west we find some rapidly growing places. Not only are there prosperous towns on the older railroads, but even in the new, recently built branches, are growing towns, and industrial conditions which are particularly gratifying: Moorhead, with its stave factories and sawmills, with its fine cotton mill; Indianola, the county seat of Sunflower county; Baird, Tchula, Belzoni, Tutwiler, Webbs, Minter City, Philippi, Graball, Ittabena, Rôlling Fork the county seat of Sharkey county; Cary, and in fact dozens of other rising places. Much of this development is the result of private ventures in railroad building, no less than three railroads, one from Rosedale to the southeast, another from Leland or Greenville to the east, and a third from Moorhead south. These were projected and either partly or wholly built by their enterprising projectors. They all now form a part of the Yazoo & Mississippi Valley R. R.



ANGE AFTER WINTERING OUT. PLANTATION OF GEO. M. HELM,
GTON COUNTY, MISS.

JEFFERSON PARISH

Assessed Valuation 1890 ....
" " 1899 ....
Area.......................... 395 squ

LAFOURCHE PARIS

Assessed Valuation 1890 ....
" " 1899 ....
Area......................... 1,024 squa

MADISON PARISH

Assessed Valuation 1899..... ....
Area..... .... 670 squa

MOREHOUSE PARIS

Assessed Valuation 1890 ....
" " 1899 ....

NATCHITOCHES PARI

Assessed Valuation 1890 ....
" " 1899 ....
Area..........................1,290 squ

OUACHITA PARISH

Assessed Valuation 1890 ....
" " 1899 ....
Area.. ....640 squ

PLAQUEMINES PARIS

Assessed Valuation 1890 ....
Area ....930 squa

POINTE COUPEE PARI

Assessed Valuation 1899 ....
Area.......... ....575 squa

RAPIDES PARISH

Assessed Valuation 1890 ....
" " 1899 ....
Area......................... 1,498 squ

RED RIVER PARISH

Assessed Valuation 1899 ....
Area...........................386 squa

RICHLAND PARISH

Assessed Valuation 1890 ....
" " 1899 ....
Area...........................578 squa

ST. BERNARD PARIS

Assessed Valuation 1890 ....
" " 1899 ....
Area.......................... 680 squa

ST. CHARLES PARIS

Assessed Valuation 1890 ....
" " 1899 ....
Area................ ....284 squa

ST. JAMES PARISH

Assessed Valuation 1890 ....
" " 1899 ....
Area ....308 squa

ST. JOHN BAPTISTE PA

Assessed Valuation 1890 ....
" " 1899 ....
Area .... 190 squa

ST. MARTIN PARISH

Assessed Valuation 1890 ....
" " 1899 ....
Area...........................618 squa

.... $3,083,975
..... 3,736,347
niles, all alluvial

..... $2,376,925
..... 2,560,334
iles, all alluvial

..... $1,766,350
iles, all alluvial

..... $2,106,455
..... 2,112,188

..... $2,789,460
..... 3,683,610
iiles, ½ alluvial

.... $2,890,408
.... 3,601,045
iiles, ⅔ alluvial

.... $1,934,005
iles, all alluvia.

.... $1,574,508
iles, all alluvial

.... $3,516,700
.... 4,604,575
iles, ½ alluvial

.... $1,003,490
iles, ½ alluvial

.... $1,260,898
... 1,296,733
iles, ¼ alluvial

.... $ 842,490
... 1,043,169
les, all alluvial

... $1,347,118
... 1,831,120
les, all alluvial

... $1,666,877
... 2,098,826
es, all alluvial

... $1,164,290
... 1,683,078
es, all alluvial

... $1,408,320
... 1,904,200
es, all alluvial

ST. MARY PARISH

Assessed Valuation	1890	$3,385,360
" "	1899	5,011,090
Area		648 square miles, all alluvial

TENSAS PARISH

Assessed Valuation	1899	$1,410,810
Area		612 square miles, all alluvial

TERRE BONNE PARISH

Assessed Valuation	1890	$1,692,744
" "	1899	2,493,049
Area		1,806 square miles, all alluvial

WEST BATON ROUGE PARISH

Assessed Valuation	1890	$1,086,580
" "	1899	2,306,160
Area		210 square miles, all alluvial

WEST CARROLL PARISH

Assessed Valuation	1899	$538,855
Area		380 square miles, ¼ alluvial

LOUISIANA

Louisiana, the pearl of the southern tier of States, the mother of a populous galaxy of daughters, the possessor of the largest area of alluvium in the Mississippi Valley, the State from which the great Mississippi, through several mouths, finds its way to the sea, is attractive and interesting from many points of view.

The romance of its early settlement, and of the "Mississippi Bubble," the antiquity of its cities, the ever-present interest in its quaint Spanish and French architecture lends charm and piquancy to its history.

But this is not a book of history. It is a book of description. It is not a book of poetry, but a book of practicality, and therefore we must deal with Louisiana as she is to-day, and with her as she will be to-morrow when her alluvium, the youngest land formation, but the richest on the American continent, fully responds to the efforts of the husbandman. Possessing nearly one-half of the entire overflow lands of the Mississippi River Valley it is the cane field and the rice field of our Southern country. There are millions of acres of land lying almost on a level with the sea which will, by drainage and by land making through some future system of hydraulics, become as fully cultivated as are the fertile fields along the bayous and on the banks of the great Mississippi. When the levees shall have been built, like the dikes of Holland, beyond the danger of recurring floods, then will the river be permitted, under some intelligent system, to build up these waste places—the same process of land

JOHN T. MICHEL
Secretary of State

LEDOUX E. SMITH
State Treasurer of Louisiana

WM. S. FRAZEE
State Auditor of Louisiana

WILLIAM W. HEARD
Governor of Louisiana

ALBERT ESTOPINAL
Lieutenant-Governor of Louisiana

FRANCIS T. NICHOLLS
Chief Justice of Louisiana
Ex-Governor

WALTER GUION
Attorney-General of Louisiana

ing. There are at various points along the Atchafalaya, the Teche, and in fact along all the bayous and lakes of this region, sawmills engaged in cutting and shipping to distant markets vast quantities of cypress, and it forms one of the most important industries of the State. The forests in the alluvial portions of the State, along the water courses, and in the swamps, are covered with moss, and its gathering and curing is an important industry, employing thousands of people.

Along the Gulf of Mexico, in the bays and lakes which mark the southern border of the State, are great quantities of fish and oysters, which also give employment to many thousands of people. The oyster industry is rather local at present, but it bids fair, under careful nursing, to be a source of great revenue to the inhabitants of the State. The area of sounds and shallow lakes, inlets, etc., which are adapted to the cultivation of oysters, is very large, in fact, the coastline of Louisiana is greater than that of any other State, save Florida.

There is an error prevalent regarding the heat of the extreme South, and that as Louisiana lies very far south that it is oppressively warm. Such reasoning is erroneous, as the water surface of the State is so great, and as in the summer time the south winds prevail, there is nearly always a cool sea breeze. The fact is, speaking of the climate of New Orleans, one might say that it is a perfect one in the wintertime, and pleasant in the summer.

There are over 3,500 miles of navigable waterways within the confines of the State.

The Louisiana State Board of Agriculture has issued a truthful and conservative statement regarding Louisiana. From its interesting pages is taken a description of the alluvial lands of the North and South of Louisiana, as well as some valuable facts regarding the raising of sugar and the possibilities of development in that line.

ALLUVIAL LANDS OF THE MISSISSIPPI RIVER

This region may be conveniently subdivided into three parts: First, alluvial of Mississippi River and its outlying bayous; second, alluvial of Red River and its outlying bayous; third, the marshes of the coast and lakes.

This region occupies about 19,000 square miles, and its vast possibilities in the near future for supporting millions of beings are simply inconceivable. The lands of this section are now leveed against the

annual encroaching floods of the rive
verse them. Large sums are annually
larging and strengthening these prot
walls. When these streams, as they w
years, shall be safely controlled in
rises, and the confidence of the peop
in the ability of levees to thoroughly
will a full appreciation of the intrin
these lands be realized, and high val
lished.

Dr. Hilgard speaks of this region
fertile agricultural lands of the State,
few and surpassed by none in the wor
tive capacity."

The parishes of this region north of
Red River are East Carroll, Madison
Concordia entirely, and parts of Mor
chita, Union, West Carroll, Richlan
Caldwell, and Catahoula. South of t
Red River the whole of the following
included in this region: Pointe Coup
ton Rouge, Iberville, Ascension, Ass
James, St. John, St. Charles, Jeffer
St. Bernard, Plaquemines, Lafourche,
St. Mary, St. Martin and Iberia. Par
les, West Feliciana and East Baton R
alluvial. In treating of the soils of
would be best, perhaps, to adopt the
and call all of that portion north of
Red River north Louisiana, and all
south Louisiana. This should be do
an agricultural standpoint, since the
northern sections are of a lighter, har
than those of the southern section.
chief crop in the former, while sugar
inates among crops in the latter.

ALLUVIAL LANDS IN NORTH

Crossing the State from the Mis
westward along the Arkansas line, o
alluvial bottoms separated by spur
running down from Arkansas, until
of the Ouachita are encountered. B
and Tiger are encountered after a
alluvial bottoms of eight miles from th
ward of these bayous begin the bayo
(bluff formation), which are here ab
wide. They extend in a widening belt
ward eight-five miles, terminating in
Their widest extent occurs just no

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boro, in Franklin parish, and is here nearly twenty-five miles.

Descending from these hills, going westward along the Arkansas line, the valley of the Bœuf River is entered. This extremely fertile valley is here also about eight miles wide and extends southward, with about the same width until it merges into the valley of the Ouachita River, eighty miles distant.

Westward of the Bœuf River "alluvials," we encounter a true ridge of the tertiary formation stretching out from Arkansas well down into Louisiana, and cut off at some remote day from the main hills by the Ouachita River and its tributaries.

This ridge has been intersected by bayou Bartholomew (which empties into the Ouachita), leaving a narrow tongue between it and its confluent. This ridge varies in width from four to thirty-five miles, and is known locally as Bastrop Hills, the town of Bastrop, the parish-seat of Morehouse parish, being situated thereon.

The Ouachita River forms the western boundary of the flood plain of the Mississippi Valley, and borders the hill country (good uplands), of Union, Ouachita, Caldwell, and Catahoula parishes. Along this river and its tributaries, bayous d'Arbonne, De Siard and Bartholomew, some of the finest cotton plantations of the State are situated. These alluvial lands are in many respects most desirable, since their easy culture, profuse fertility and absence of levees (the upper Ouachita being above the highest overflow), all conspire to give profitable returns under good culture and management. The tertiary ridges mentioned above are similar to the good uplands described elsewhere. There are some "prairies" scattered through these ridges, with soils varying from pure sands to whitish clays. In Ashley county, Ark., similar prairies, with the latter soils, have, by drainage and tillage, been made highly profitable.

Seymours' and Dubull's, in northern Morehouse, and Prairie du Bois, in southern Ouachita, are of sufficient size to merit a distinct coloring on the agricultural map of the State. Prairies Mer Rouge and Jefferson lie at the eastern foot of the ridge in Morehouse parish. They are extremely fertile tracts of a few thousand acres each, and properly belong to the "bluff formation." The name of the former, Mer Rouge (Red Sea), is derived from the prevalence of a sumac (Rhus copalina), whose ber-

ries in autumn are brilliantly red.
a few hawthorn, are the only trees
prairies.

The Mississippi River Commission
of the overflow lands of Louisiana a
miles or 9,404,800 acres. Thus
of the total area given by the Mi
Commission lies in the State of Lou

Descending the western banks of
River from the Arkansas line to t
lands are found, and the entire cou
wholly alluvial. Levees construct
tained at public expense extend this
and protect the lands from overflow
Examination will show that the hi
this alluvial region are immediately
the river. This is true of every str
flows its banks in high water. It i
throughout its course by a ridge, t
the debris deposited by it in each s
flow. From this ridge the lands sl
low-lying cypress swamp, which is us
age basin between the two streams.

The bank of the Mississippi Rive
opposite Vicksburg, Miss., is eight
banks of the Tensas, twenty feet
fourche, and ten above Monroe, o
the Ouachita. Before the days o
overflow carried the waters to the
and frequently filled the entire alluvi
up to the banks on both streams. T
stricted settlement on these lands i
now, with our system of levees perf
pected that they will be rapidly occu

The soil next to the river is not o
in elevation, but is, as a rule, the lig
est—the amount of sand dependin
the size and velocity of the stream
Hence, on the Mississippi River, soil
profitable cultivation are sometimes
sandy or loamy front lands can easily
ed from the stiff back lands by the tr
north Louisiana the tree growth of
is cottonwood, which is supplanted
on similar lands in south Louisiana.
elsewhere, the front lands are for
posits from the present river, while
are the deposits from an ancient stre
dated our present river, and one w
little or no current. They closely re
soils now being formed in our swa

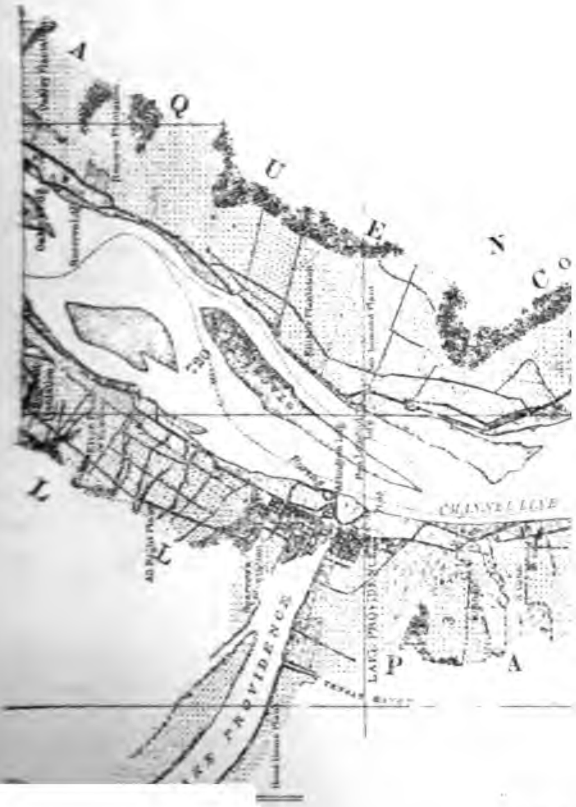
universally known in north Louisiana as "buckshot" lands, on account of the excellent quality which they possess of crumbling into small roundish fragments on drying—a property which gives them the highest agricultural value, since they combine the high fertility of clay soils with the easy tilth of light, loamy ones. The dark, buckshot soils are esteemed, for permanent productiveness, the finest soils in the world.

Analyses made of similar soils from Mississippi by Dr. Hilgard, show them to contain the largest amount of plant food, and "justify the reputation of being the most productive and durable soil of the Mississippi bottoms." Unlike most other clay soils, they may be tilted at almost any time when the plow can be propelled through them, because, on drying, they crumble spontaneously into a loose mass of better tilth than many an elaborately tilled upland soil. It is of such a depth that the deepest tillage, even by the steam plow, would not reach beyond the true soil material; and its high absorptive power secures crops against injury from drought. At the same time (owing, doubtless, to its being traversed by innumerable fine cracks and underlaid by gravel or sand), it drains quite readily. The front lands are also highly esteemed, and but for the proximity of the "buckshot lands," with which they are compared, they would be held of the highest value. Drainage and proper tillage will always evoke from these soils the highest yields.

SOUTH OF RED RIVER

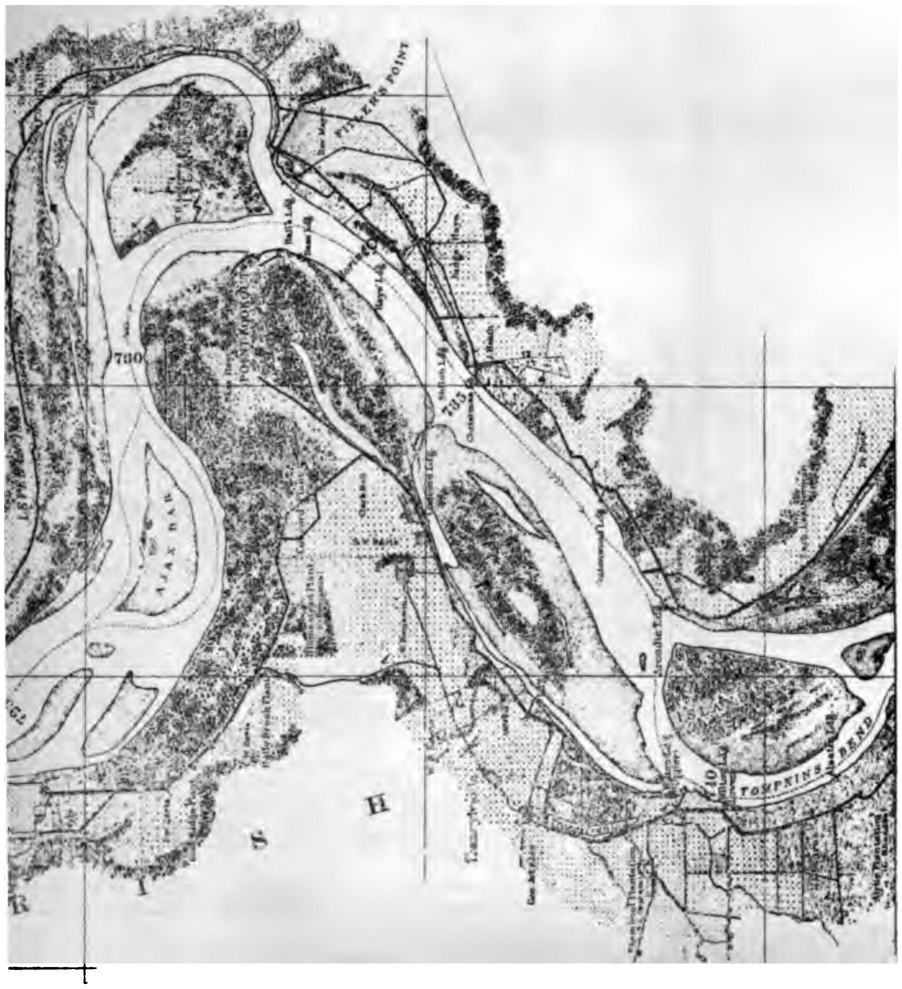
Here the scene changes. Both the crops and the landscape vary from those described. Sugar cane now becomes the chief crop, while the cultivatable soil adjacent to the banks decreases in width as we descend the river. Above the Red River all of the so-called bayous became ultimately tributaries of the Mississippi. Below Red River there is a perfect network of bayous, leaving the river outlets to the Gulf for the enormous volumes of water pouring through the Mississippi in times of flood. Along these bayous lie extensive areas of arable land, cultivated in sugar cane, corn, rice, etc. Here, as well as on the banks of the Mississippi, extensive and highly improved sugar plantations, with palatial homes, large and splendidly equipped sugar-houses, and well arranged laborers' quarters, are everywhere to be found. Between the bayous and back from the main river occur extensive swamps of cypress and swamp cane, the latter less

LANDING A

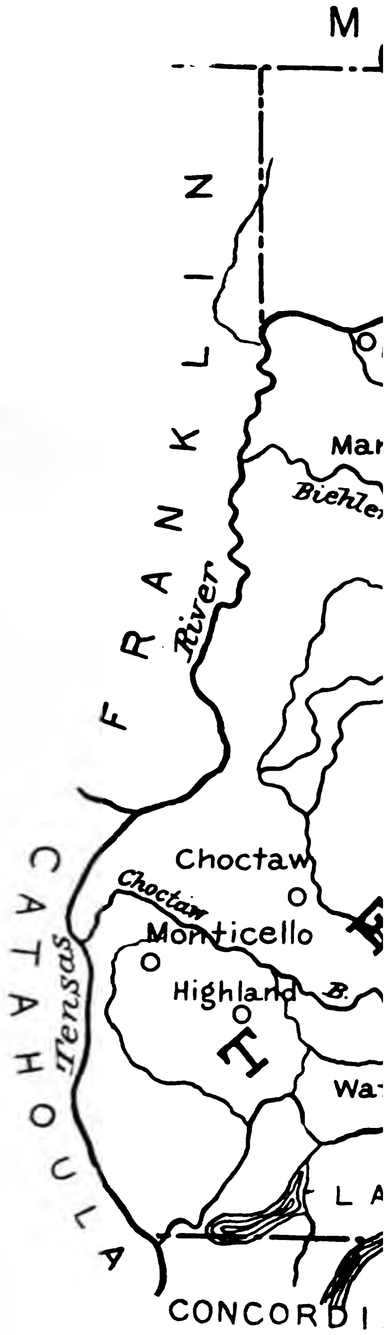


THE M

KE PROVIDENCE—TOWN IN THE DISTANCE



SIPPI RIVER AT LAKE PROVIDENCE, LA.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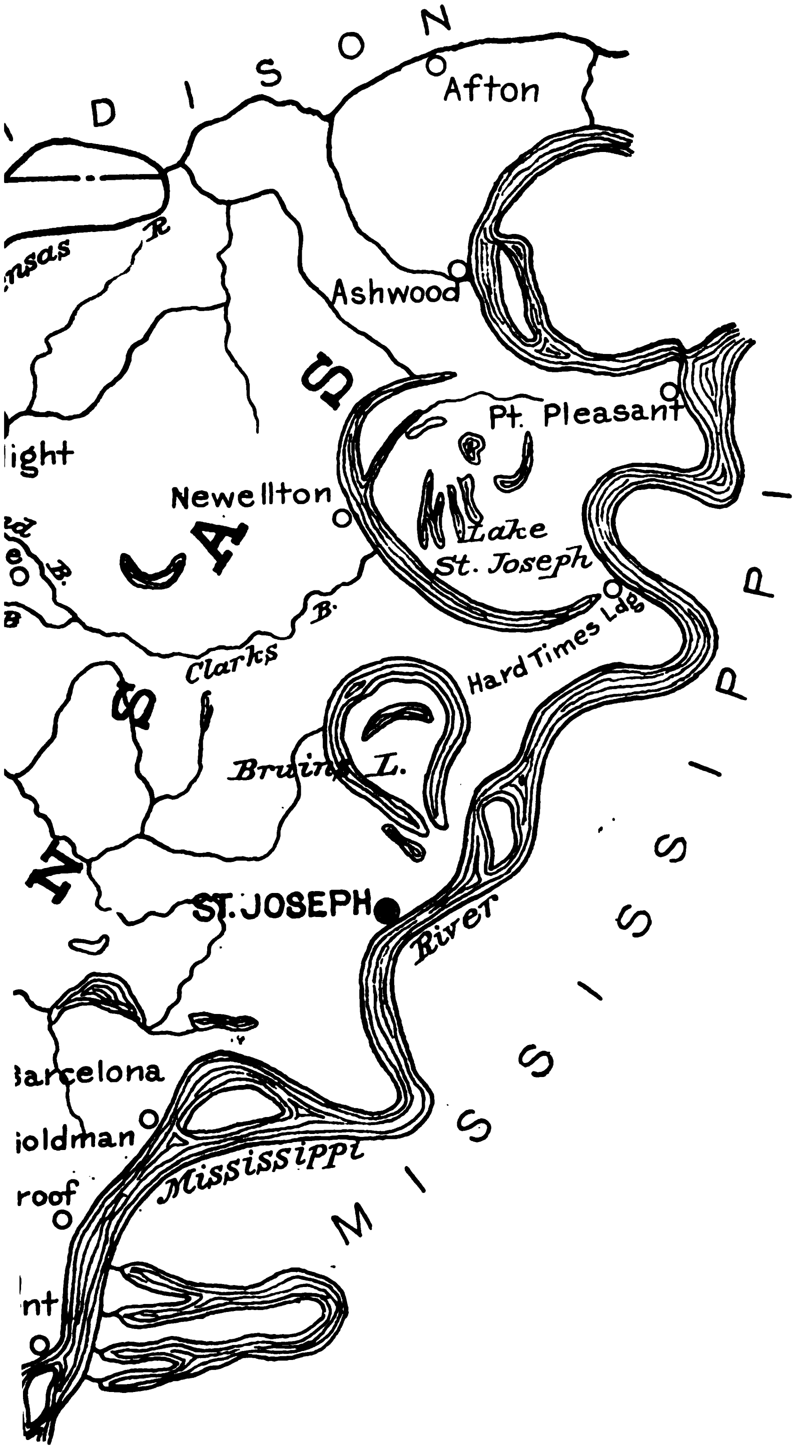
CATAHOULA
CONCORDI



For population, see page 352; other statistics, page 518.

abundant near the coast. The la
the river varies in breadth from or
while on the bayous it is from a fe
to one or two miles. Back of the
are the wooded swamps, into whicl
the plantation is sent.

Sometimes detached portions o
ing no present reference to any
streams, are found four to ten mil
ent water courses. They are usua
timber, and in clearing, the latter
such clearings are usually know
Again, small islands just up out o
abound in swamp cane, which fu
grazing for stock in the winter.

To these islands, cattle were f
large numbers, and hence were cal

As we descend the Mississippi,
varied in character. As a rule the
and true buckshot soils are rare.
probably too deep to take part i
Usually the soils of this region
three classes—"sandy," "mixed," a
vary only in the proportion of cla
those with the least are called sand
the largest amount stiff. The mix
mediate in character. As a rule, th
the most esteemed, being easier til
Their relation to heat is such that
to start vegetation in the spring a
fall to be affected by frosts. The
is true in regard to the stiff soils.
color, they absorb heat rapidly in
thus force an early vegetation. I
count of rapid radiation of heat, t
to be hurt by the frost. They are
and cultivate, and hence are not in
the other hand, they usually give
but a lower tonnage per acre t
Mixed soils possess properties
tween those described, and are ver
probable that for all purposes th
valuable of the three. It frequen
all three of these soils may occur in
fact, so frequent in the immediate
crevasses and overflows that the e
of south Louisiana may be ascribe
original deposits made by the rive
were being formed, and before
levees, are rarely within the rea

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plow.

Hence the diversification of soils within a small area.

Numerous analyses of soils taken throughout south Louisiana have been made, covering every variety from the sandiest to the stiffest clay, and they all show them to be rich in the essential elements of plant food, and, as a rule, require only physical amelioration (chiefly drainage and good culture), to produce excellent crops. Since all these lands slope away from the river to the swamps, they can, as a rule, be easily drained by open ditches. Tiles have also been used successfully and extensively. Their great cost have prevented their general use.

It would not be supposed that south Louisiana alluvial parishes, which have been largely developed for generations, should show great increases like those counties in Mississippi, Arkansas, and Missouri, which are younger and have had less levee protection, but there are many surprises, no doubt, in store for even those who live in Louisiana.

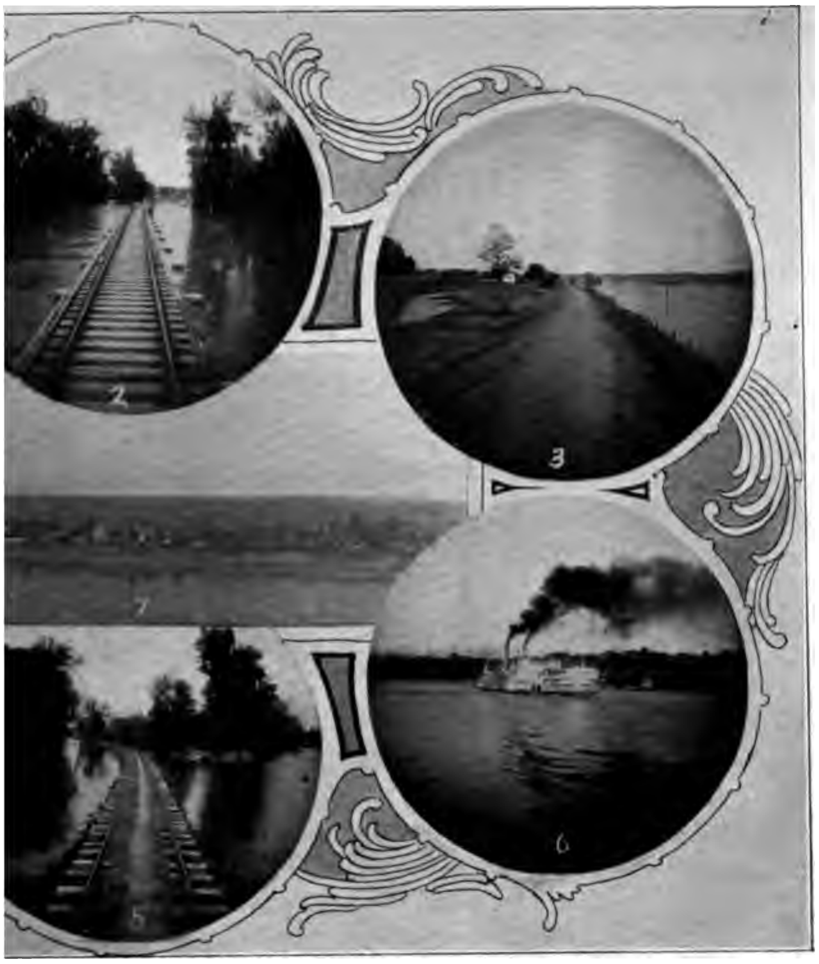
Take for example the parish of Ascension, one of the old pronounced sugar parishes of the state, and one generally regarded as well settled; in 1880 the population was 16,895. In 1900 we find it with 24,142, an addition of one-half to its population of the former date.

And this is not due to the fact that it lies on the Mississippi River, for Iberia, which lies on the western edge of the alluvial sections has advanced from 16,676 in 1880 to 29,015 in 1900, a still larger increase. Ouachita parish in the Ouachita valley, Natchitoches, Caddo, Rapides in the Red River valley, show the greatest increase. The three parishes named in the Red River valley have almost doubled in population. Nearly all of the towns and small cities show gratifying improvement. Louisiana plantation methods and the comparative absence of general manufactures is not conducive to city growing, yet the towns and cities of Louisiana are steadily advancing in population in keeping with the general increase in the state. Many large hardwood lumber manufacturers have located in these regions, attracted by the magnificent wealth of cypress and other hardwood varieties of timber which abound in such profusion, and have either built up new towns, or materially increased the existing ones near which they have located. Lutcher, in St. James parish, and White Castle in Ascension, are conspicuous examples of those built up by the large mills. Lumber mills have also contributed largely to the growth of Baton Rouge, Donaldsonville, Plaquemine, Morgan City, Alexandria, Shreveport and other places.

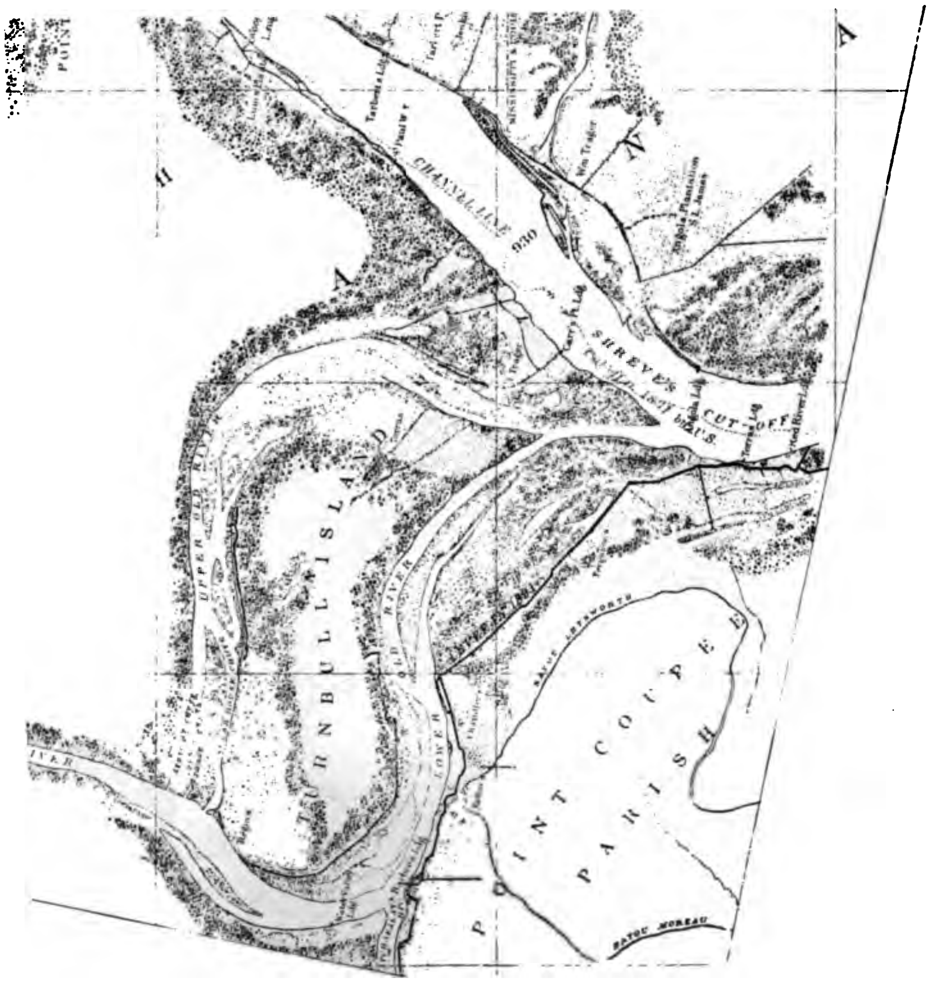
The improved conditions and the increase of population in southern Louisiana may be largely attributable to the almost perfect levee conditions which exist below the mouth of Red River. That this view is correct is shown by the fact that the upper tier of parishes, which lie on the river between the Arkansas line and mouth of Red River, show very little increase in population. These parishes are large and fertile; indeed, Carroll parish was the banner parish of the United States in the production of cotton, as shown by one of the late decennial census reports, but these parishes have been a prey to frequent disasters by breaking of levees—all of them except East Carroll suffering in that manner as late as 1897. The last named parish escaped the overflow in that year. These parishes, as well as in others which lie immediately in the rear of them, offer abundant opportunities to investors in timber and agricultural lands. There are all kinds of hardwood timber growing in the great bottoms and swamps which lie in the parishes of the Carrolls, Madison, Concordia, Tensas, Richland, Franklin, and the lands when denuded of their timber become the finest farming lands in the world. Large bodies of these lands have been sold within the last few years at very low prices, and there is still much more to be had at figures which will enable almost anyone to secure a fertile and valuable farm for a very small amount of money.

In the back of this book are found two pages devoted to a list of real estate agents and men who are interested sufficiently in the good of the country to reply to inquiries regarding these alluvial lands.

SOME LEVEE DEFENDERS—POLICE JURY OF CONCORDIA PARISH



IE NEW ORLEANS AND N. W. RAILROAD DURING THE FLOOD OF 1897



NORTH OF RED RIVER

CO
Up. Old
Low. Ol
Merrick
Legonier
Red River Ldg
Lettsworth
Fishers B.
Jacoby
Williamsport
Latanache
Coyles B.
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ST. LANDRY
Atchafalaya River
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Ra
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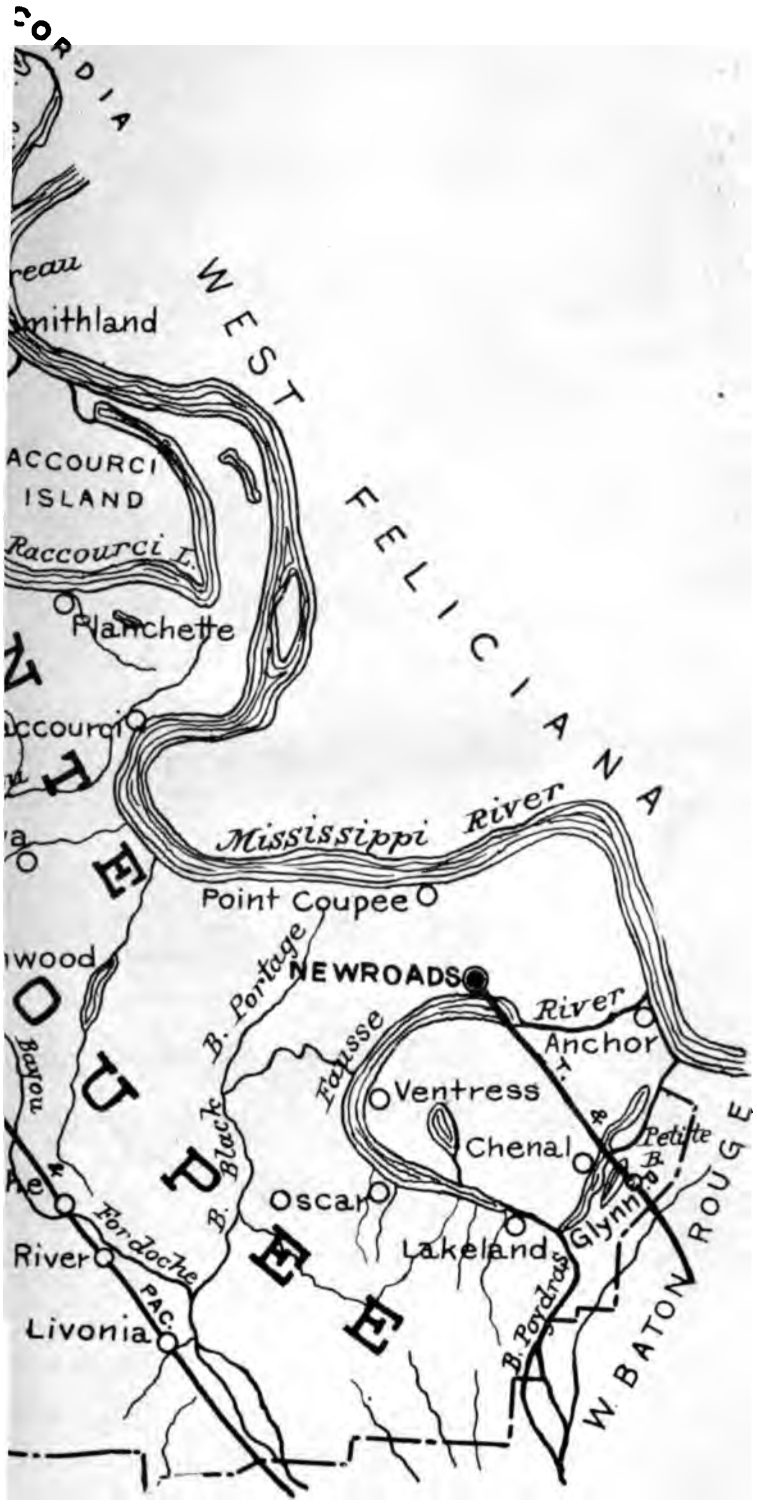
B. Gerance
Alabama B.

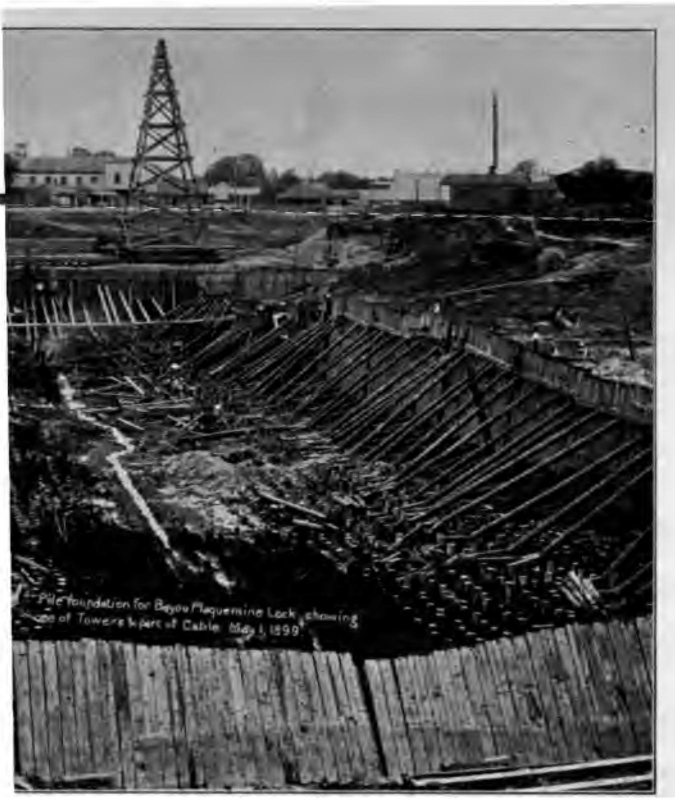


n, see page 352; other statistics, page 518.

CONSTRUCTING LOCK

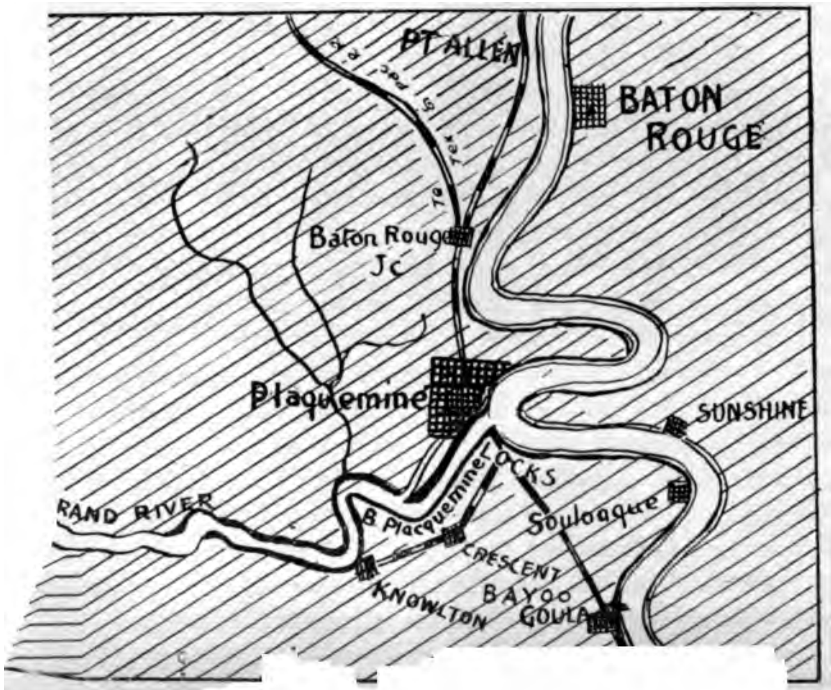
SHOWING LOSS

BAYOU PLAQU


Pile foundation for Bayou Plaquemine Lock, showing one of Towers & part of Cable. May 1, 1899

QUEMINE. (Later scene shown in a group further on—ED.)

G LEVEE BEHIND PART OF THE TOWN OF PLAQUEMINE



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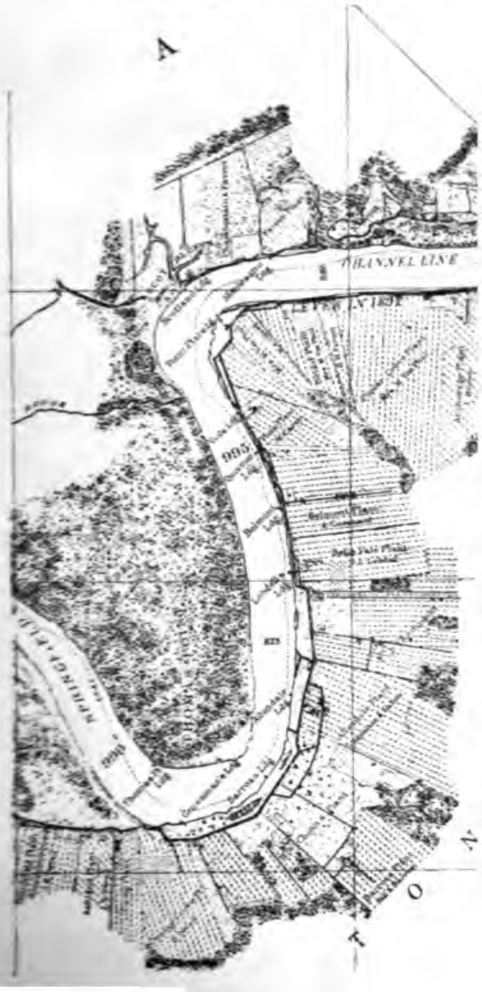
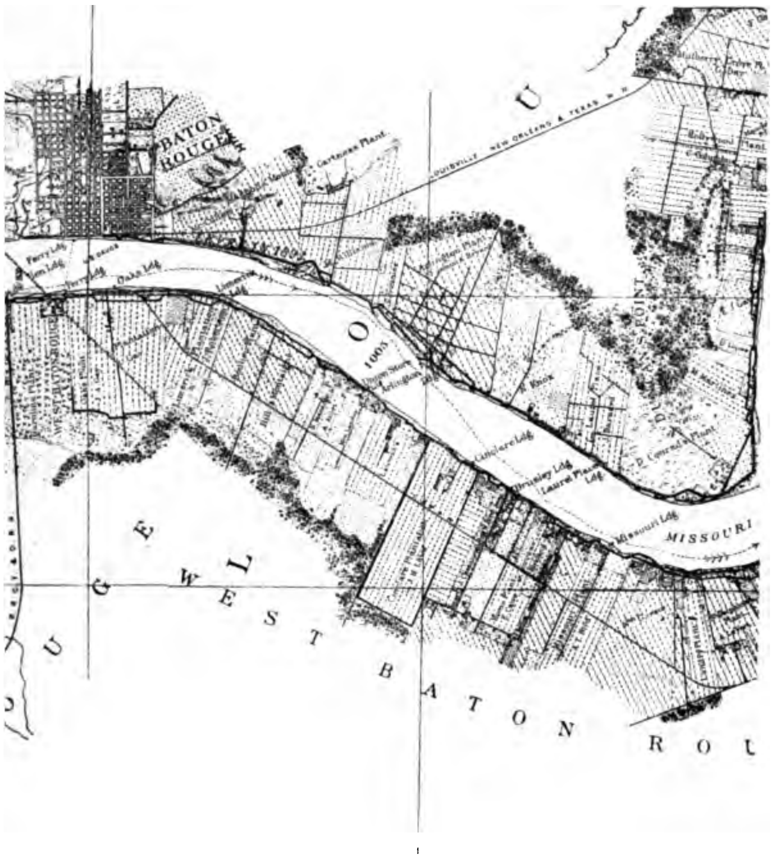
A NEW AND BEAUTIFUL HOME OF BATON RC



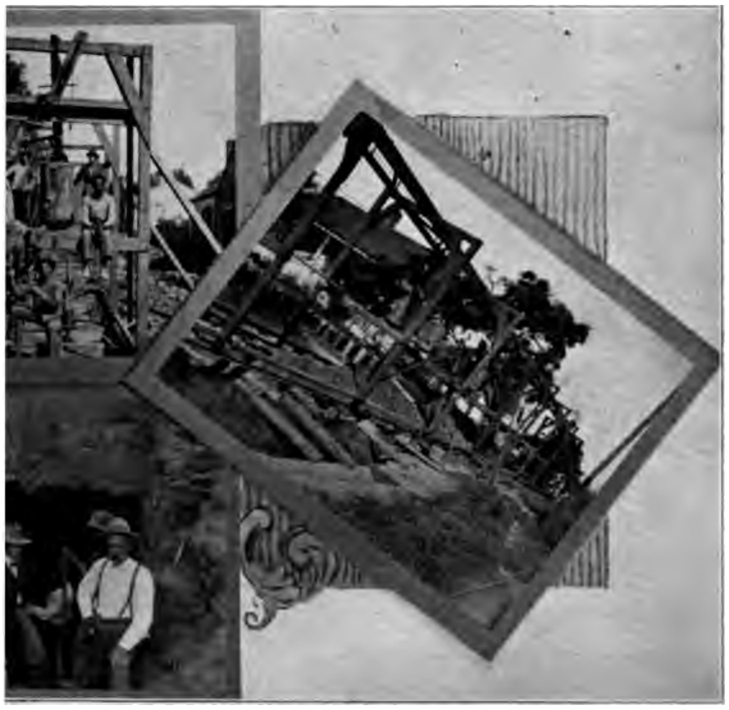
FIRST NATIONAL BANK OF BATON ROUGE



T BATON ROUGE

L

SCHOOL BUILDING.



ER SYSTEM OF BATON ROUGE.

1 New City Hall
2 Government Post Office Building
3 Institute for Deaf and Dumb
4 Steamer at landing with levee outfit

B

2

3

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7

8

10

for Blind
La Fayette Street
Court Building

8 Capitol Building
9 Episcopal Church
10 Governor's home

ROUGE, LOUISIANA

THOMAS D. BOYD

President Louisiana State Universit

WILLIAM C. STUBBS

Director of Experimental Station, Louisiana Sta

WILLIAM GARIG
President Executive Board, Louisiana State University

ROBERT A. HART
Mayor of Baton Rouge

CADET BARR

THE "CC

ISIANA STATE UNIVERSITY, BATON ROUGE, LA.

ISIANA STATE UNIVERSITY, BATON ROUGE

PAS

DEPARTMENTS OF AGRICULTURE AND

BARNS, EXPERIMENT STATIO

TRY, LOUISIANA STATE UNIVERSITY, BATON ROUGE, LOUISIANA

ISIANA STATE UNIVERSITY, BATON ROUGE, LOUISIANA

countries, and most inviting and luc
employment are opening to its gradu
in the various branches of the suga
in great demand. One of the young
the university has recently accepted
Hawaii, at a salary of $6,000 a year.

"The courses in mechanical and civ
not only give thorough training i
mathematics, but fit the student to fil
that are rapidly opening to capable
engineers. The graduates in civil en
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course specialize in chemistry, for w
University offers facilities and adv
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UGE SUGAR REFINERY

dents present, and the number will run over 400 before the close of the session.

"The General Assembly at its last session was unusually liberal in its appropriations to the university, and in consequence many improvements are being made. Before the beginning of the next session a large three-story brick building will be completed and will contain a mess hall for 500 cadets and dormitories for 150.

"The Louisiana State University, like many other Southern colleges, has suffered from lack of means, but the indications are that its growth will soon cease to be retarded by this cause. Not only is the state fully alive to its needs, but private individuals are coming to its assistance. The most memorable event of the last year was the generous gift of an assembly hall by Mr. Wm. Garig of Baton Rouge, and the alumni of the university, under the leadership of their able and indefatigable president, Mr. Lewis S. Graham of New Orleans, will soon add a handsome alumni memorial hall to the buildings on the campus.

"The people of Louisiana have just cause to feel proud of their State University and to give it their hearty support. Since its foundation it has had within its walls hundreds of men who have achieved success or risen to eminence in private or public life. It may point with pride to a glorious past, but it may also look with hope and confidence to a far more glorious future.

"It will reach the close of the old century with the prestige of forty years of usefulness and of success commensurate with its means and its opportunities. It will enter upon the work of the new century with a strong faculty of able and devoted instructors, with a growing corps of enthusiastic students, representing the highest type of young American manhood, and with increasing financial support from public and private sources."

KEN

INERY, PLAQUEMINE PARISH.

ERY ROOM.

DRYERS

VACUUM PANS

The above gives a total crop of
pounds of sugar, and was accompanie
molasses of 20,820,130 gallons. T
operation in 1896 and 1897, 230 sug
ing vacuum pans, which gave an o
778,470 pounds of sugar, with an a
pounds of sugar per ton of cane grou
pounds of sugar per acre. The cro
gathered is the largest in the history
sugar raising and will probably excee
pounds. There were 165 small oper
houses, which turned out 62,921,0
sugar, equal to 180 pounds per ton of
and 2,360 pounds of sugar per acre.
voted to sugar cane in Louisiana is
acres. This can be almost indefinit
Even in those parishes where sugar
is the chief industry, there are still lar
may be profitably devoted to the c
plant, and will be in the very near fut
central factories become more nume
already erected shall increase their c
eral of the parishes given above are
cane only in very limited areas, whil
acre on them can be profitably use
culture.

In the parishes given above there a
square miles, or about 10,000,000 acr
in cultivation at the present time ab
of acres, or one-tenth of the area,
about 300,000 are in cane, producing
tons of sugar annually, or about one-
total amount consumed in the Unit
the entire area now in cultivation in
could be devoted exclusively to can
would produce one-half of the sugar
our entire country. But there are, bes
in these parishes susceptible, with but
of being brought under cultivation, a
be done, the total area available for
in these parishes would be amply suff
all the sugar demanded by the peopl
country.

CENTRAL FACTORI

The cost of a central factory capab
daily from 300 to 1,500 tons of cane
all modern machinery suitable for th
of the best sugars, will be from $75,00
The profits from such factories, if we
be sufficiently large to justify capitali
them. At the same time thousands of

**preceding are given engravi
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of many of these factories**

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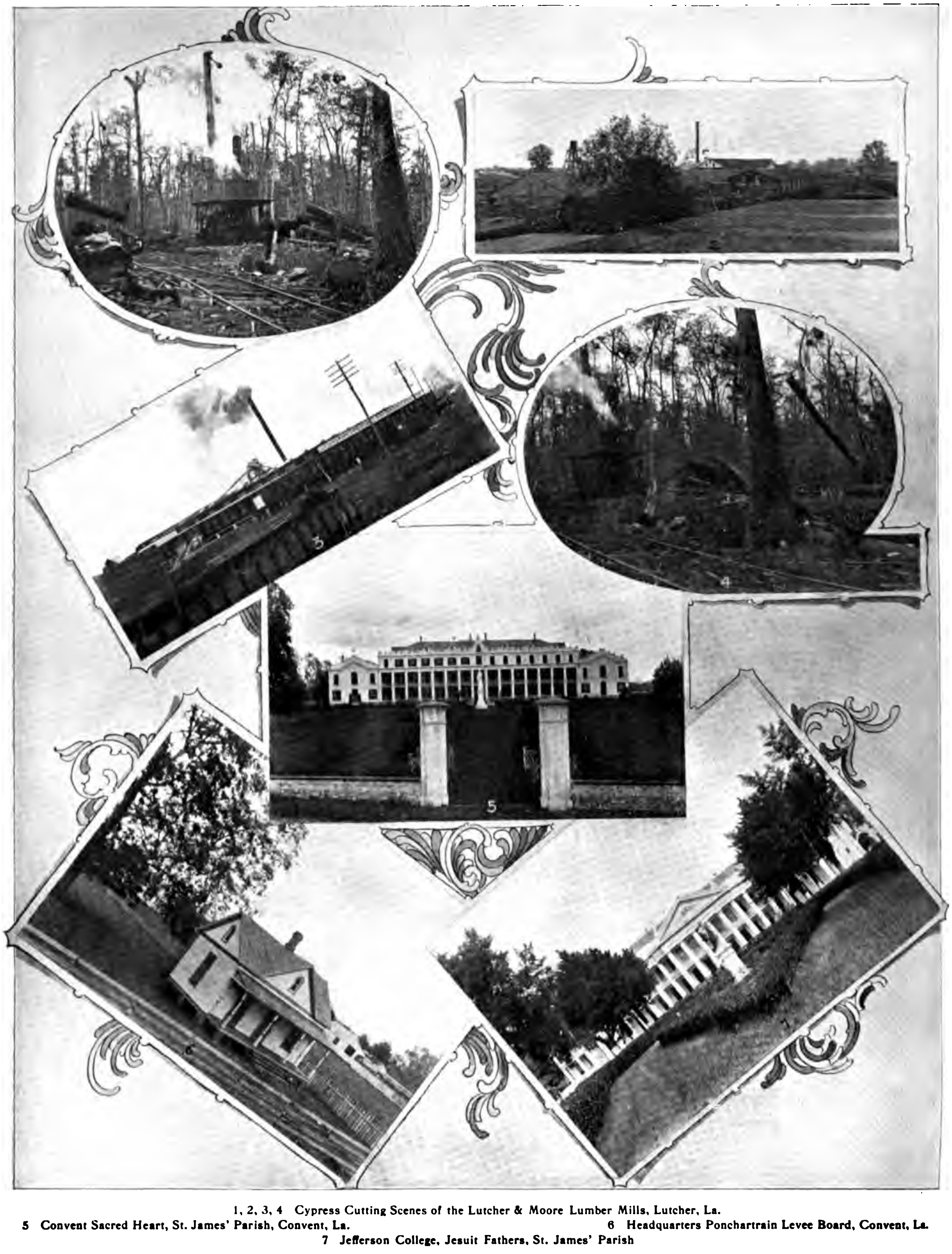
and planters stand ready to grow the cane whenever the factories are assured.

Formerly every cane culturist was also a manufacturer, and upon every plantation of sugar cane was to be found a sugar house of sufficient capacity to work up the crop grown. To-day the scene is changing, changing rapidly. Central factories exist —some that do not cultivate cane at all, but purchase every stalk crushed; others that grow only a part, large or small, of the large amount consumed. The presence of central factories presupposes the existence of cane farmers in close proximity. Many central factories already exist, and others will soon be built. The fierce conflict between low prices and profitable returns has forced out of existence many a small and incomplete sugar house, and will ultimately drive out the remaining ones. Ponderous machines, with extensive capacities, must hereafter manufacture the crystalline product of sugar cane. It requires a large amount of cane to supply the daily demands of a large central factory; 1,000 to 1,500 tons per day is now a moderate allowance for the largest. Under these new conditions, the growing of sugar cane for sale to these factories is quite extensively practiced. Small farmers, with ten acres of sugar cane, can find a ready market for it, just as readily as the large planter, with one hundred times this crop. The crops of both are in demand. Growing cane by the ton for sale to central factories is quite a profitable business, and many have embarked therein.

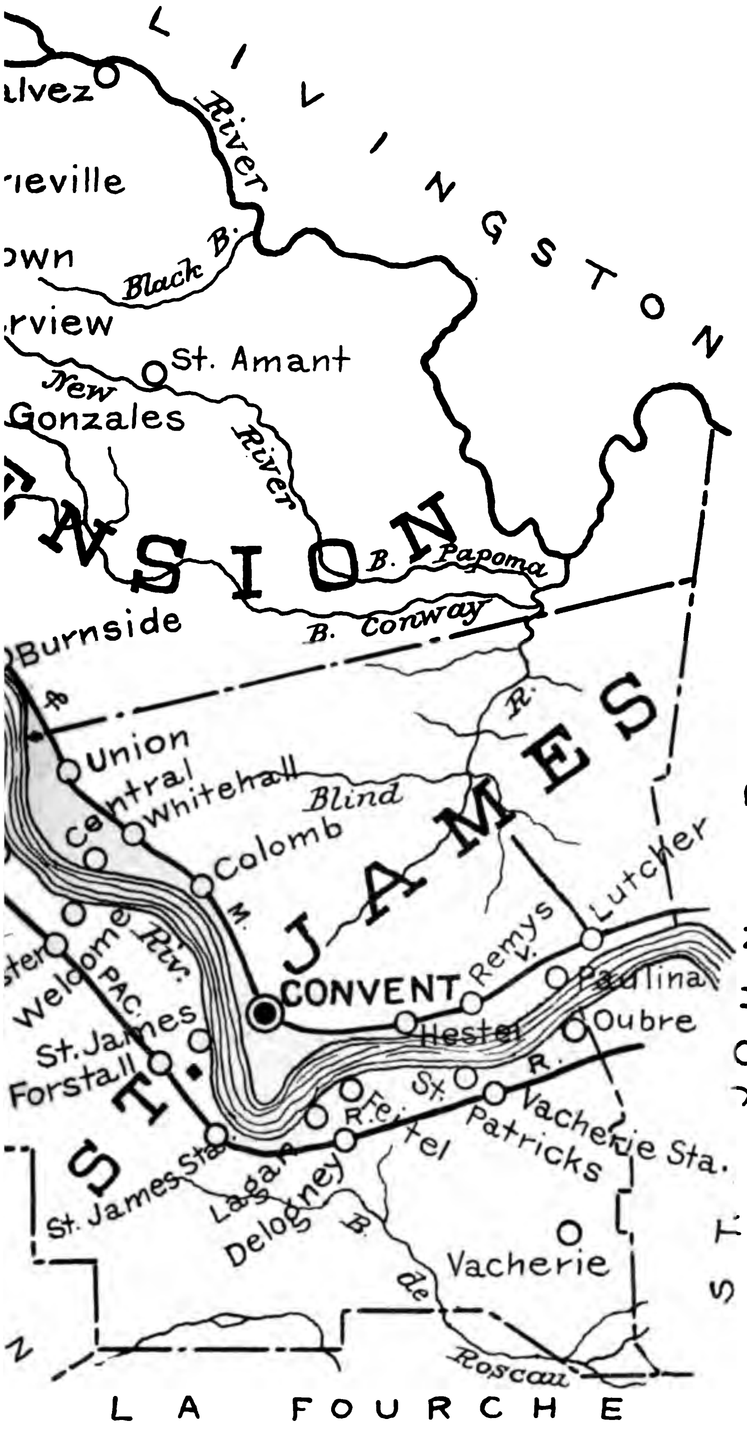
Sugar cane is bought upon a basis of values for a certain grade of sugar, and hence, when the latter is ruling high, the former conforms to it in price. No enterprise is more inviting than that of raising sugar cane by the ton for the factories. Lands in any quantity may be purchased or rented well adapted to the growth of cane. The capital required will depend largely upon the magnitude of the enterprise. One's own labor, if intelligently decided, will accomplish a great deal towards the cultivation of twenty to thirty acres of cane. Additional help will be required in planting and harvesting the crop. Good land will make from twenty to forty tons of cane per acre, and at present the factories are paying eighty-five cents to one dollar per ton for each cent per pound that prime yellow sugar brings in the market of New Orleans. There is a large field in Louisiana for the investment of capital in central factories and for intelligent labor to grow the cane.

or views of a representative Sugar Factory — the Kenilworth, lately built—
ll over the State which are mentioned on the above page. In subsequent
wn —ED.



1, 2, 3, 4 Cypress Cutting Scenes of the Lutcher & Moore Lumber Mills, Lutcher, La.
5 Convent Sacred Heart, St. James' Parish, Convent, La. 6 Headquarters Ponchartrain Levee Board, Convent, La.
7 Jefferson College, Jesuit Fathers, St. James' Parish

VIEWS ALONG THE MISSISSIPPI RIVER SOUTH OF BATON ROUGE


LIVINGSTON
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River
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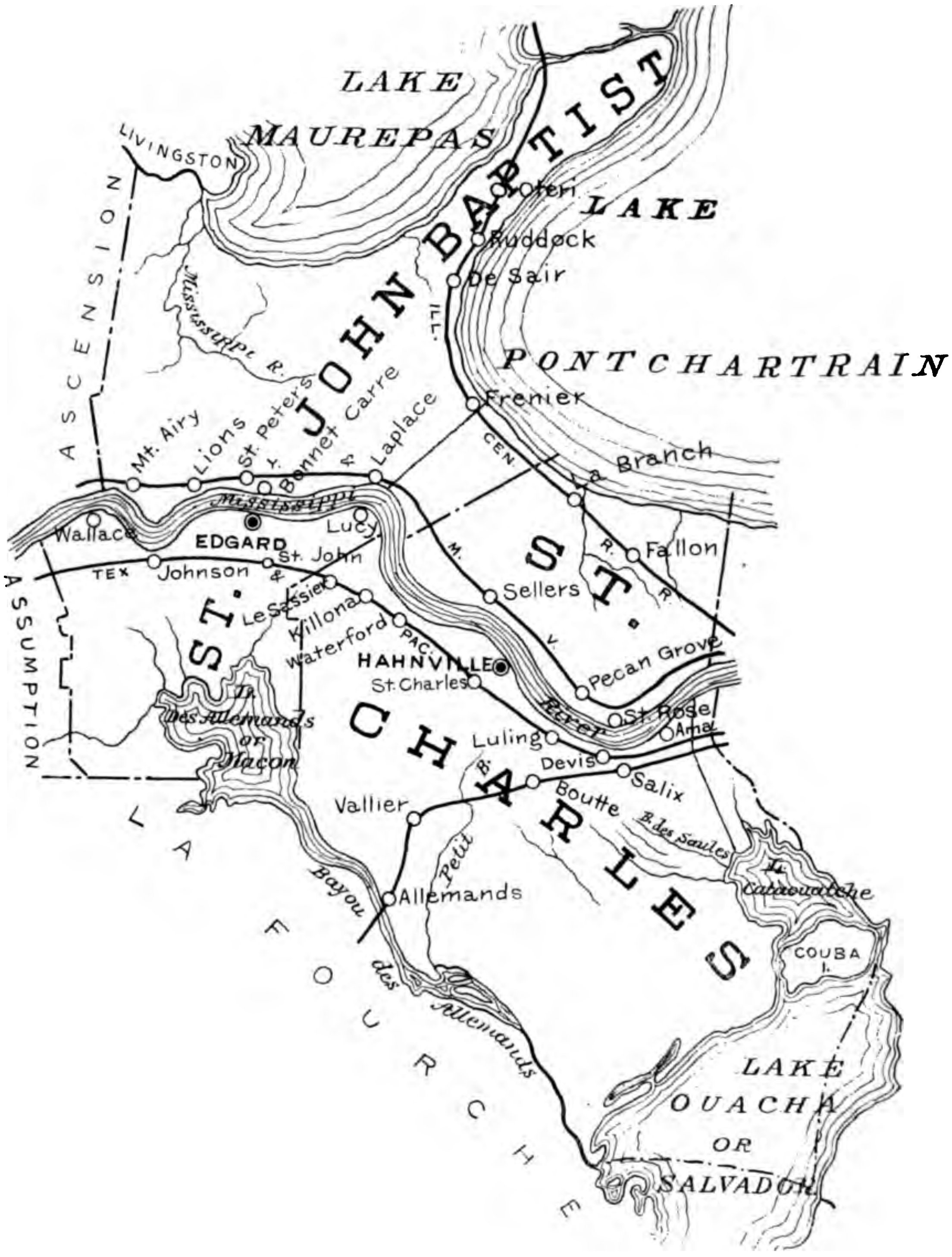
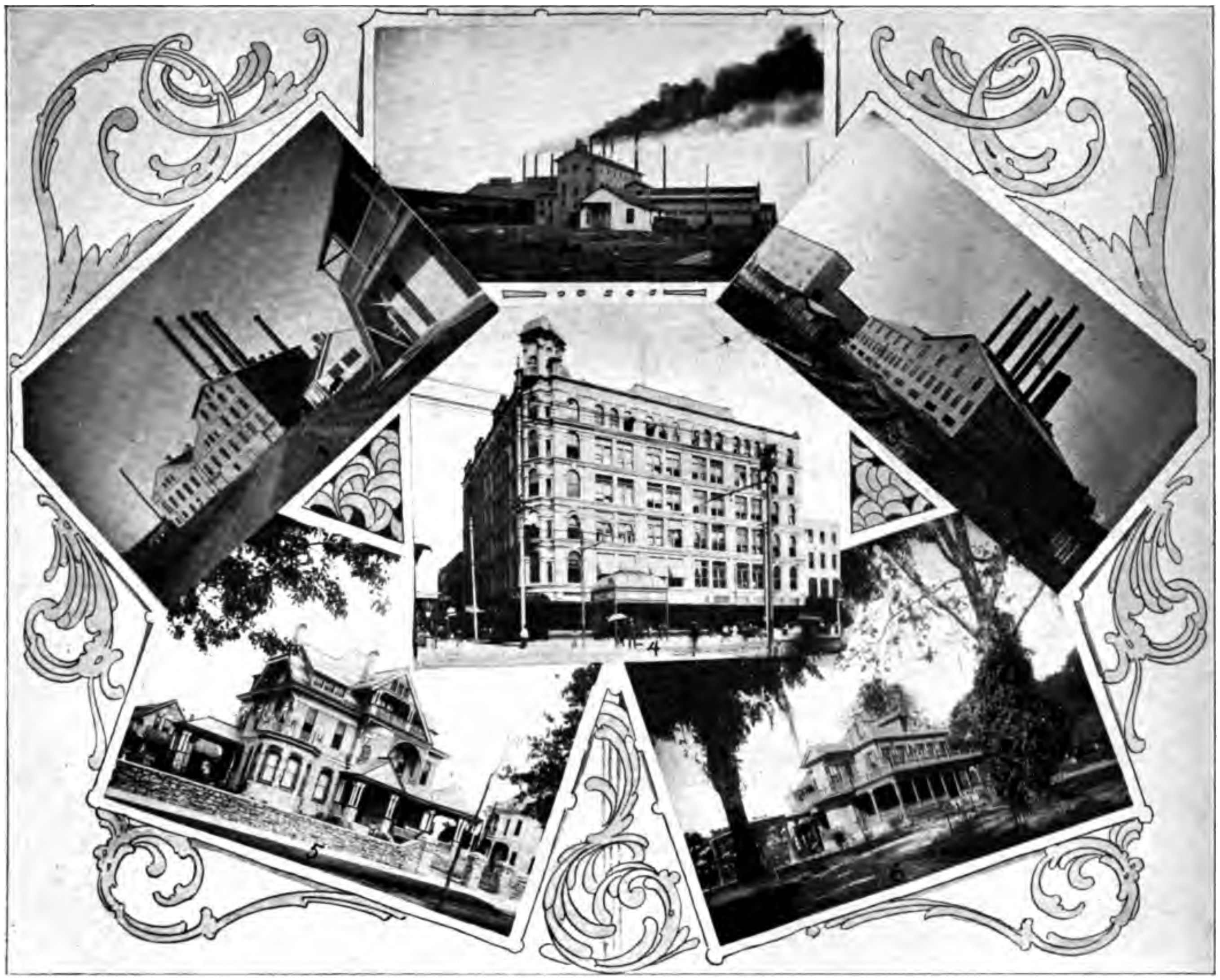
St. Amant
New River
Gonzales
River
NSION
B. Papoma
B. Conway
Burnside
R.
Union
Central
Whitehall
Blind
Colomb
ST. JAMES
M.
Riv.
Welcome
PAC.
St. James
Forstall
CONVENT
Remys V.
Lutcher
Paulina
Hester
Oubre
R.
S.t.
R.R.
Feitel
Patricks
Vacherie Sta.
St. James Sta.
Lagan
Delogney
B. de Roscau
Vacherie
ST. JOHN BAPTIST
LA FOURCHE



For population, see page 352; other statistics, page 518.



1 Elm Hall Refinery, Napoleonville, La.
2 Raceland Refinery, Raceland, La.
3 Reserve Refinery
4 Godchaux Building, New Orleans, La.
5 Residence of the Late Leon Godchaux, New Orleans
6 Residence of Walter Godchaux, Napoleonville

GRAMARCY SUGAR CO., GRAMARCY, LA.

HOME OF LIEUTENANT-GOVERNOR ALBERT ESTOPINAL, ST. BERNARD PARISH

THE BELAIR SUGAR REFINERY OF JOHN DYMOND

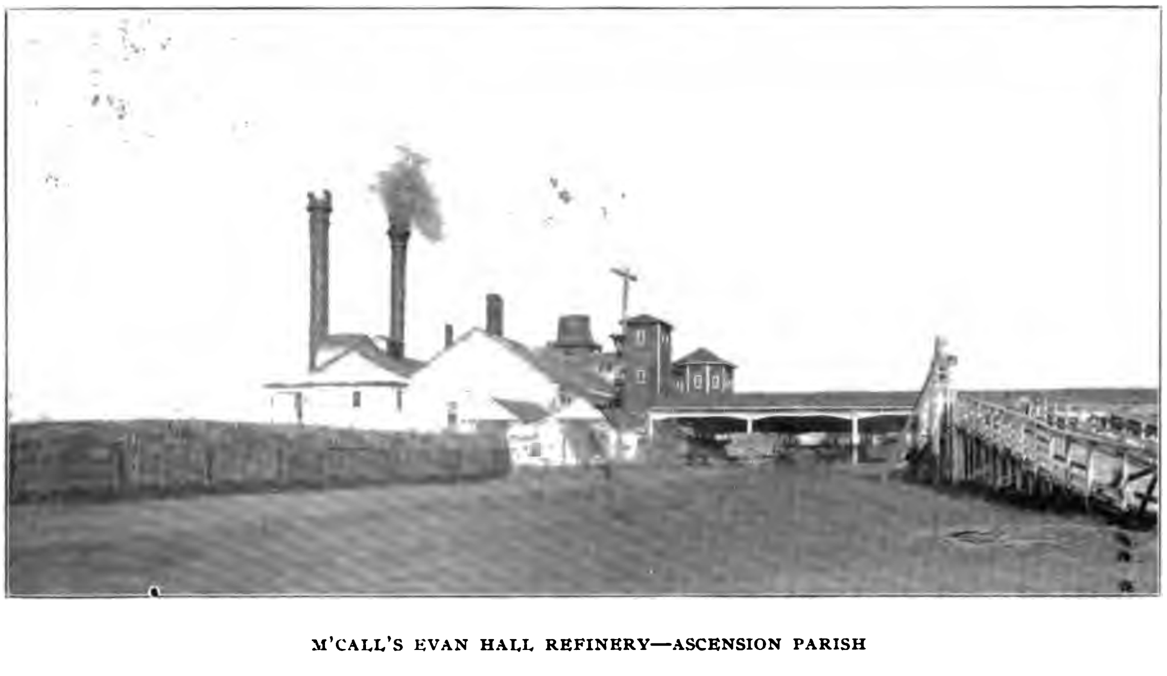
CAFFERY REFINERY, FRANKLIN, LA.

BAYOU LA FOURCHE.

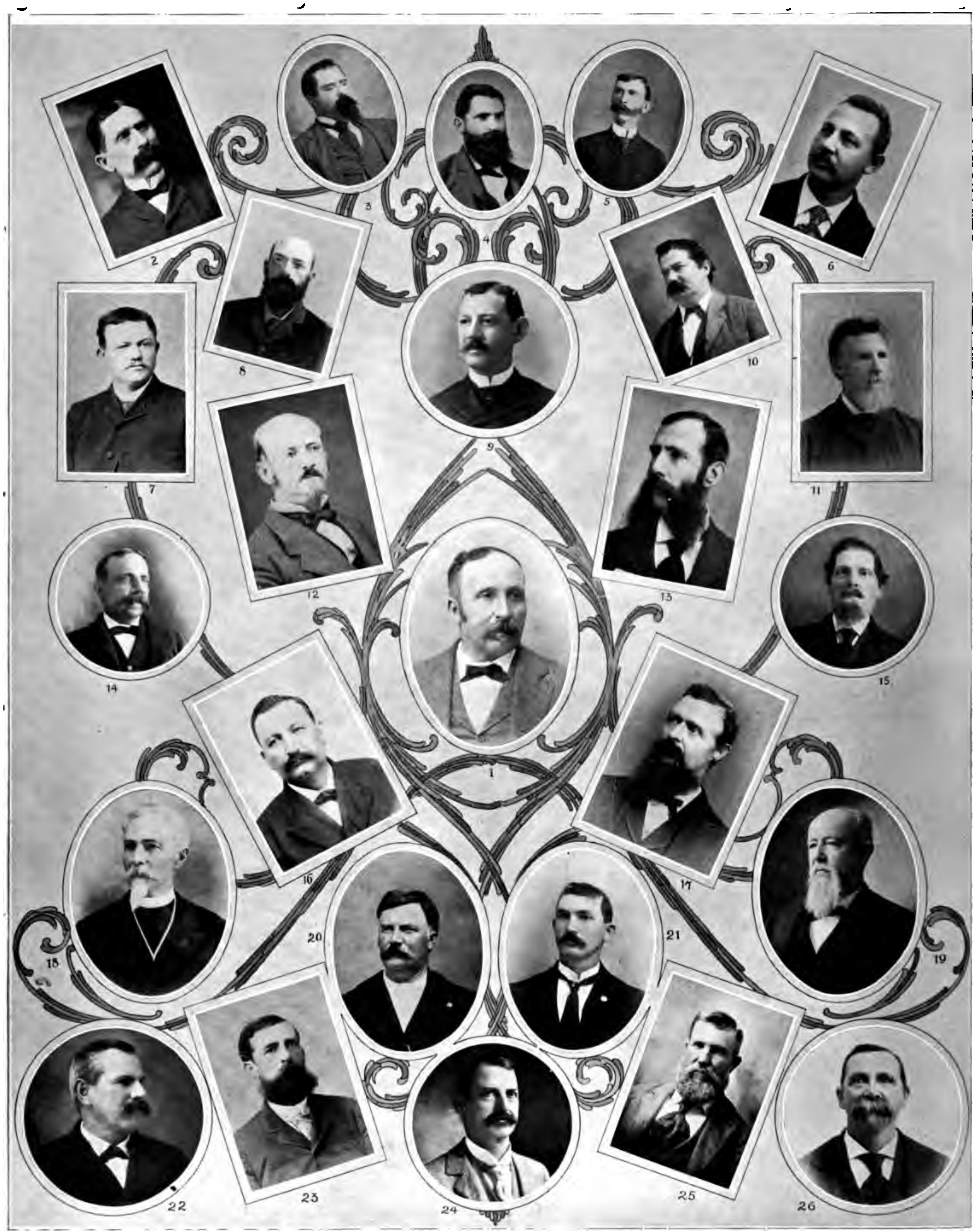
One of the best cultivated sections of the State of Louisiana lies on the two sides of this bayou, which debouches from the Mississippi River at Donaldsonville and empties finally into the Gulf of Mexico. From Donaldsonville to as far south as below Lockport there are continuous sugar plantations—some of the largest and finest in the state. The tendency of all offshoots from the parent river is to close themselves. This tendency first shows itself nearest the point at which they enter the Gulf, and lower Bayou La Fourche has filled and shoaled to such an extent that it makes the problem of levees to hold the waters from sweeping over these magnificent plantations, quite a serious one. These levees have, perforce, been raised almost yearly to meet these changing conditions at the mouth, and it has been almost impossible to prevent crevasses from taking place, especially near the lower end of the bayou. It is shown by the reports which have been made to Congress that a lock at the source of this river at Donaldsonville would be immeasurably cheaper than the present expensive levee system, besides giving approximately the same facilities of navigation. Were there no changing conditions in the bayou and had the line of high water remained at it was a few years ago, it is probable that the unrestrained navigation which has existed would have been regarded by the planters and merchants as sufficient compensation for the occasional dangers of crevasses, and the expense of maintaining these levees. But these conditions have decided them overwhelmingly in favor of a lock, and a strong movement, as above mentioned, is being made to secure prompt action from Congress in this direction.

On accompanying pages are shown some engravings of general scenes and fertile plantations along this bayou. By the very nature of things it was impossible to secure photographs of all the beautiful residences and fine sugar houses which exist so numerously. Indeed, some of the most attractive must remain unpictured by reason of lack of these from which to make engravings.

Along the banks of the La Fourche, besides Donaldsonville, which lies at its point of departure from the river, are Paincourtville, Plattenville, Labiedaville, Napoleonville, the parish seat of Assumption parish, Thibodaux, the parish seat of La Fourche parish and one of the most prosperous as well as one of the largest of the south Louisiana towns, and Lockport, and several other smaller places.

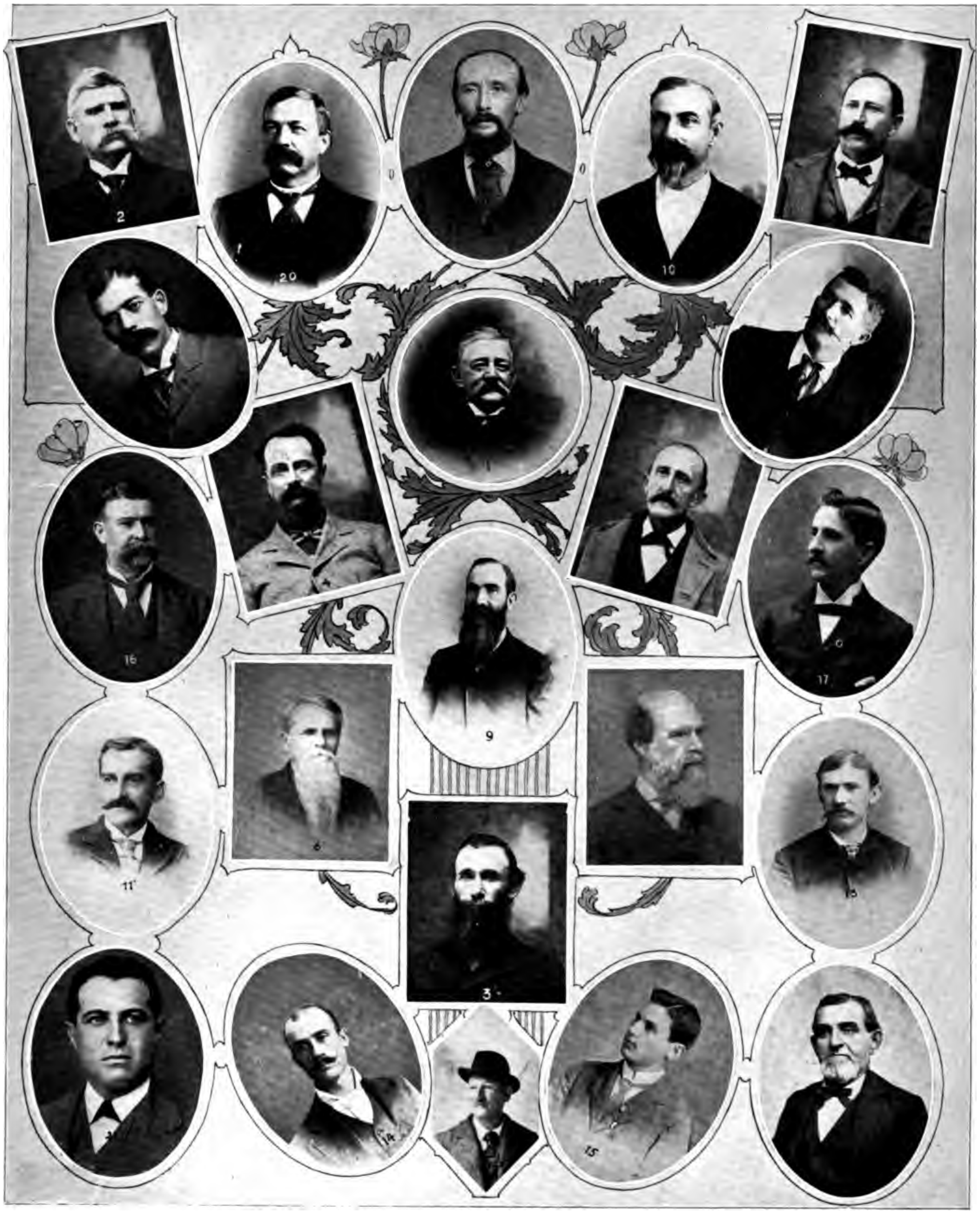


M'CALL'S EVAN HALL REFINERY—ASCENSION PARISH



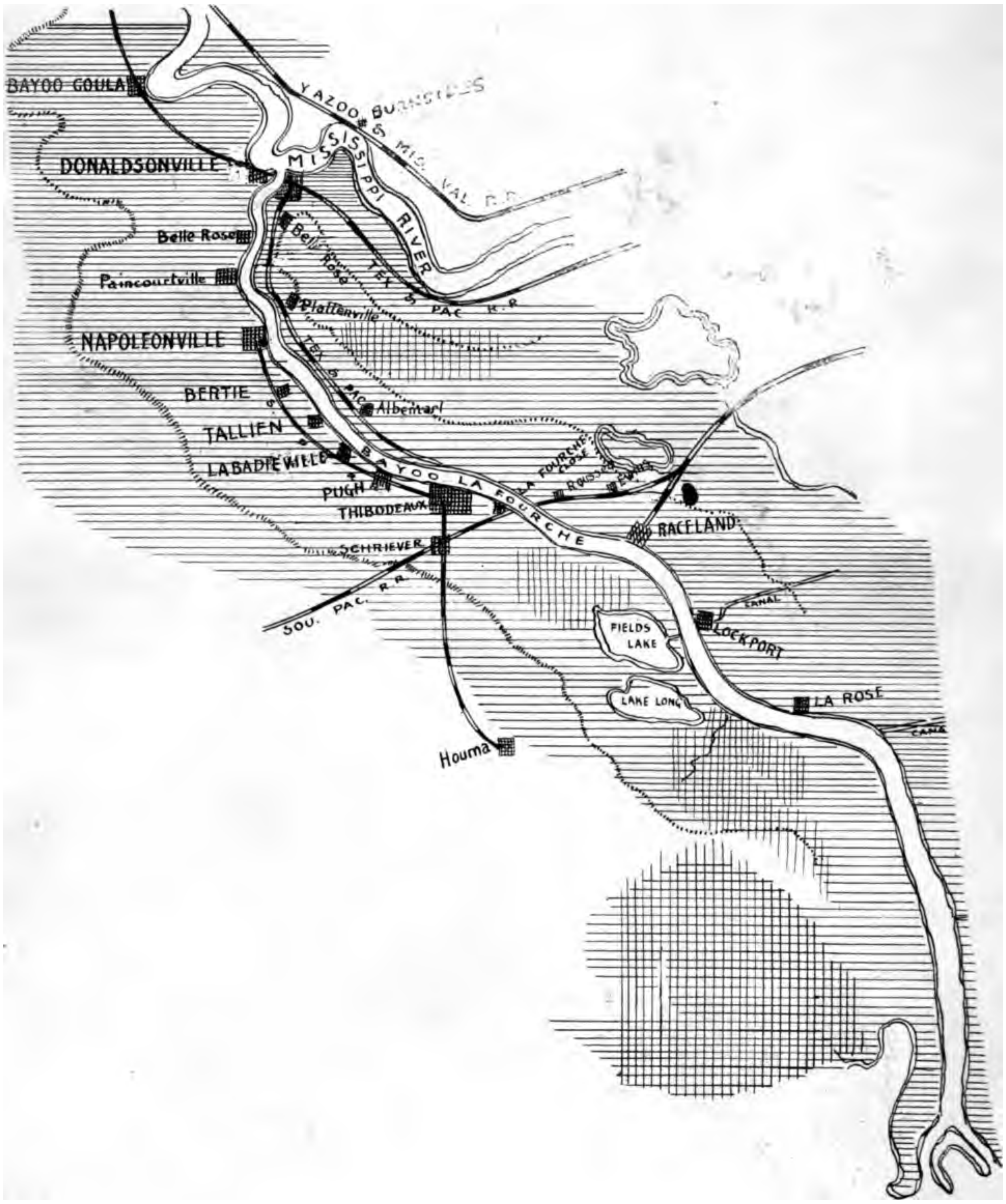
1 Robert Nicholson, East Carroll
2 Phillip McGuire, East Carroll
3 A. B. Armstrong, Madison
4 P. L. Lorio, Iberville
5 E. W. Pike, Assumption
6 J. Rumsey Duke, Ascension
7 Albert S. Coltharp, Madison
8 Jules B. Savoie, Plaquemine
9 Henry L. Weil, Ascension
10 John S. Bargas, Iberville
11 Martin Glynn, Point Coupee
12 A. E. Bass, Tensas
13 Henry C. Braud, Ascension
14 J. F. Lassus, St. Mary
15 L. V. Landry, Iberville
16 Amedie Frederick, Ascension
17 H. M. Floyd, Madison
18 R. Prosper Landry, Ascension
19 H. S. Nichols, Tensas
20 H. T. Brown, Ascension
21 J. B. Erwin, Madison
22 John Wilberts, Iberville
23 Wm. B. Bowers, Madison
24 P. D. Quays, East Carroll
25 John I. Brown, Iberville
26 Jules A. Ayraud, Ascension

SOME MEN WHO HAVE BEEN ACTIVELY

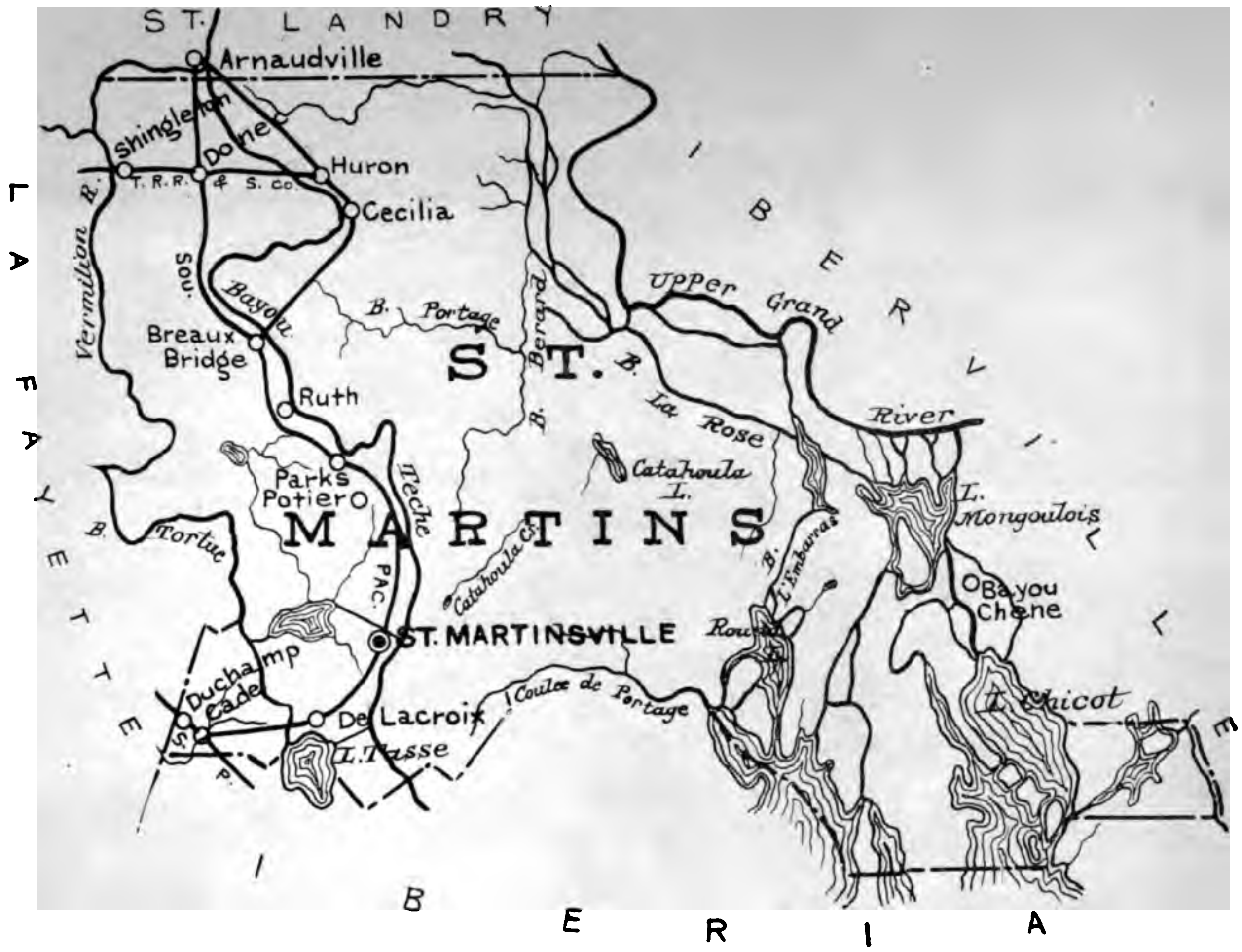


1 Dudley Avery, Iberia
2 H. Romero, Iberia
3 Albert Landry, Iberia
6 John D. Broussard, Iberia
8 A. Decuir, Iberia
9 G. W. Bolton, Rapides
10 L. B. Claiborne, Pointe Coupee
11 John Ehret, Jefferson
12 Henry Hart, Jefferson
13 J. Spies, Jefferson
14 F. L. St. Martin, Jefferson
15 Edwin P. Brady, Jefferson
16 L. H. Marrero, Jefferson
17 John R. Langridge, Jefferson
18 Valentine Betz, Jefferson
19 Henry Gardey, Jefferson
20 Representative Wilbert, Iberville
21 Jules Godchaux, Lafourche
22 W. C. Carruth, Point Coupee
23 Wm. Rebentisch, Jefferson

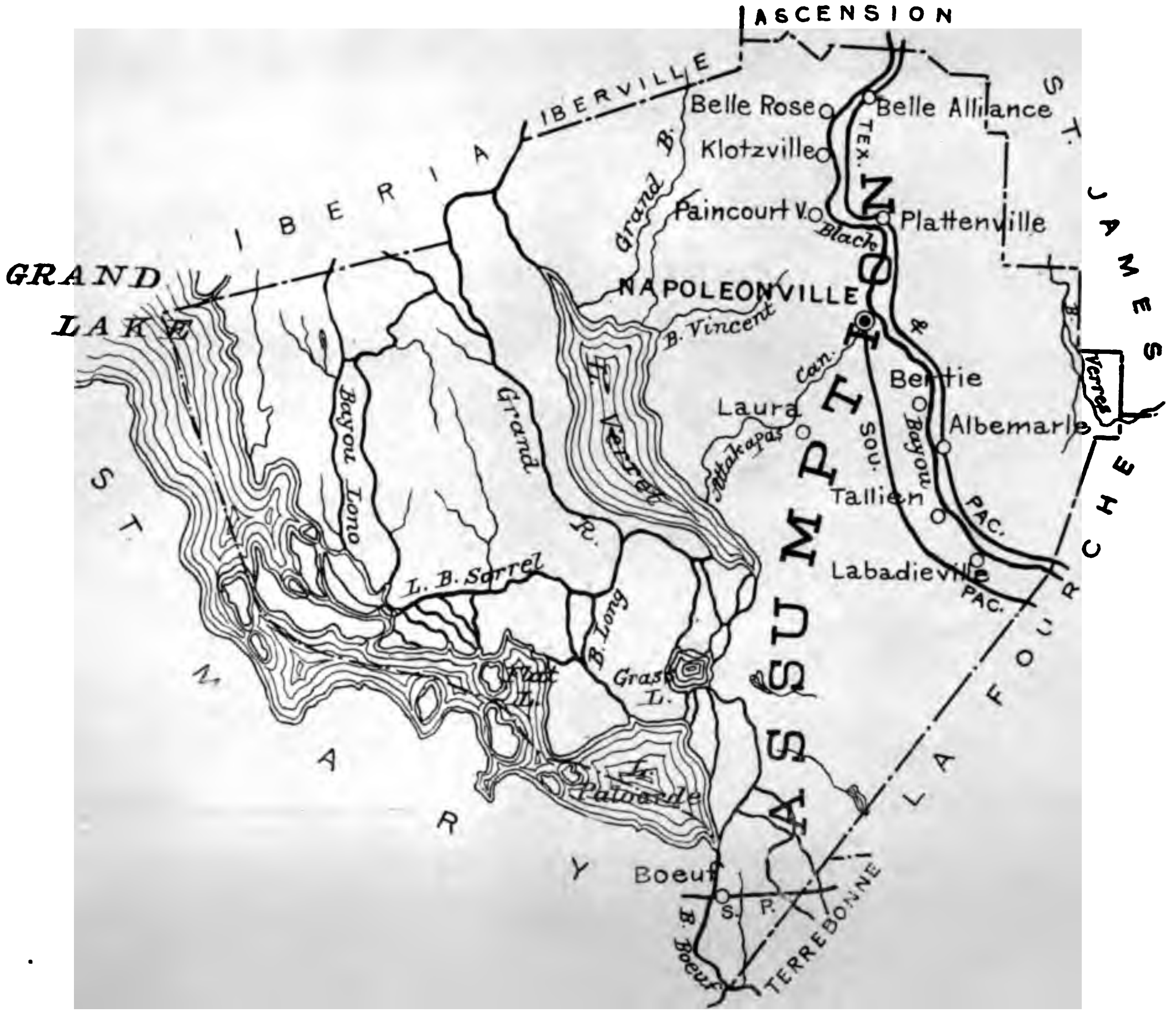
IDENTIFIED WITH LEVEE MATTERS IN LOUISIANA



BAYOU LA FOURCHE—A PART OF THE GREAT SUGAR DISTRICT OF LOUISIANA

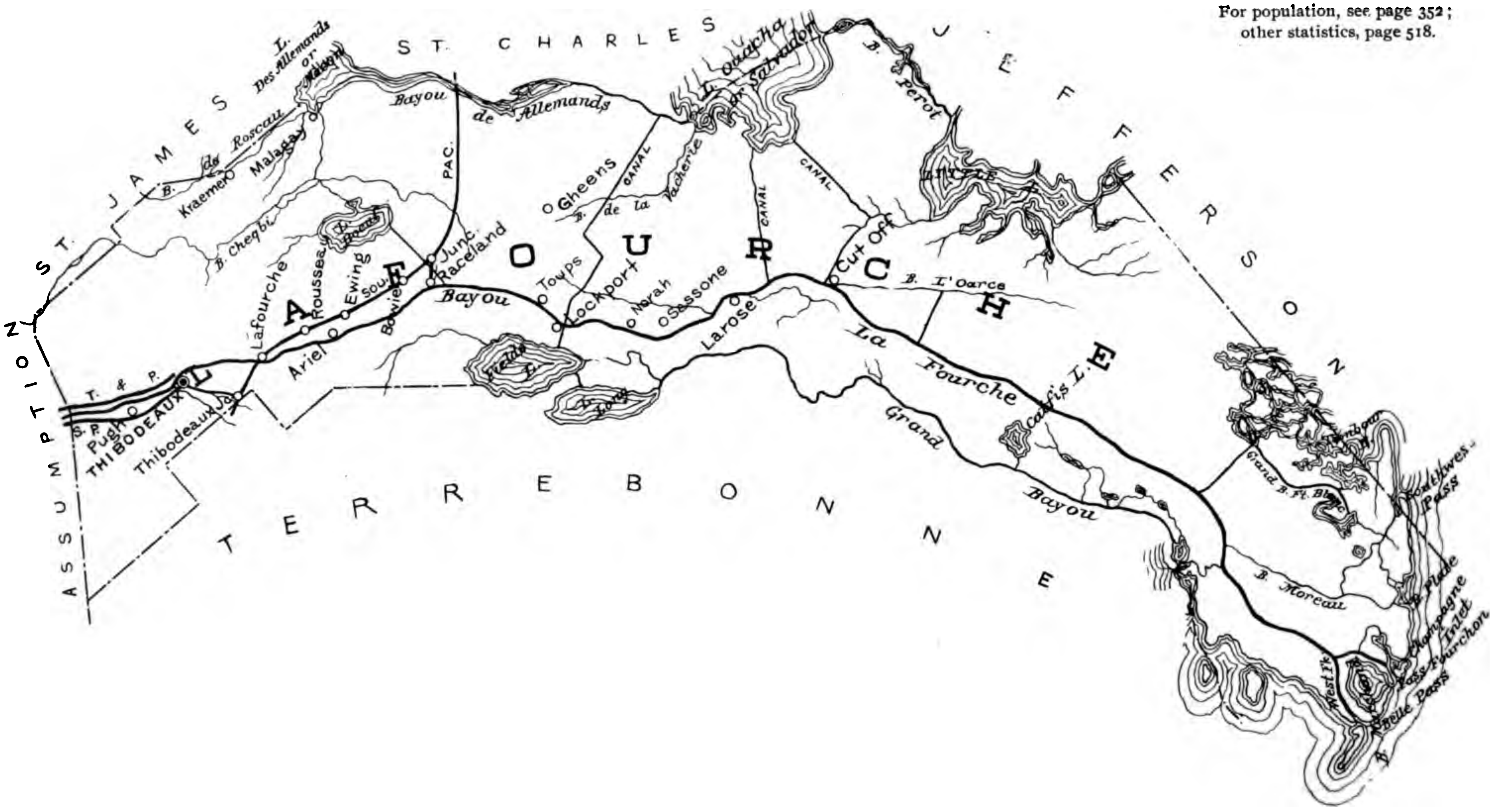


For population, see page 352; other statistics, page 518



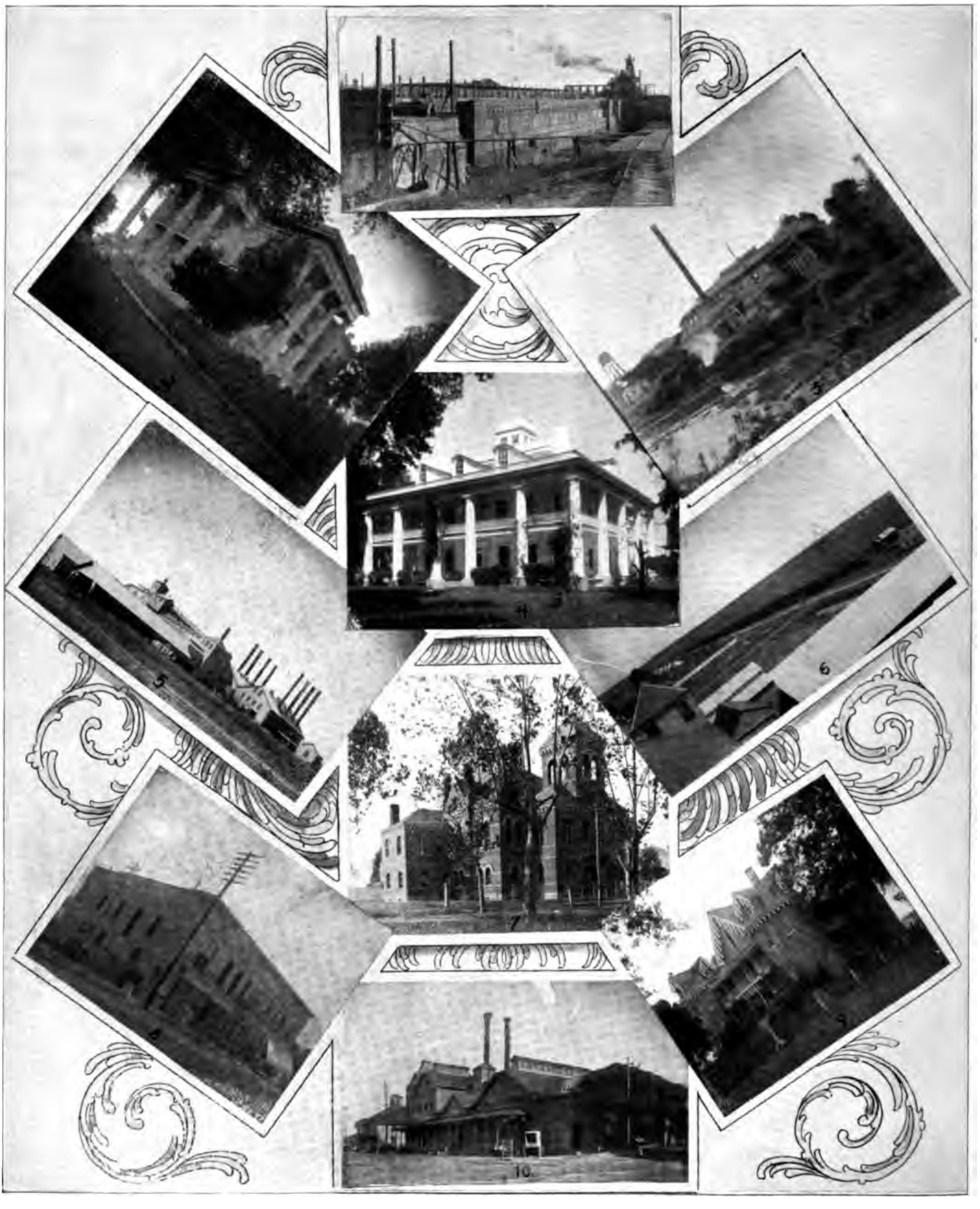
For population, see page 352; other statistics, page 518

For population, see page 352;
other statistics, page 518.

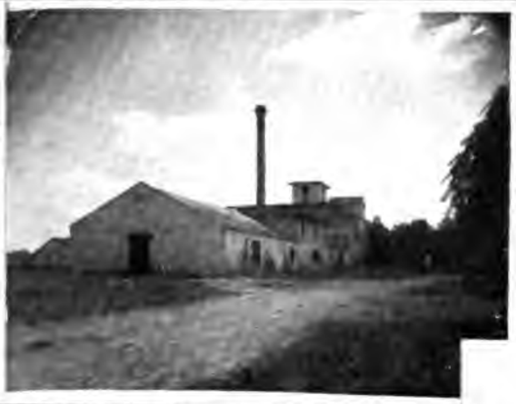


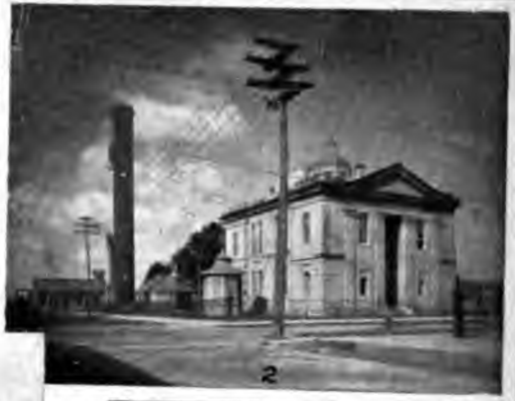
1 Sugar Factory on Belle Alliance Plantation, Mr. Koch, Prop.
2 Residence of E. J. Koch, Belle Alliance, La.
3 Entrance to Bayou La Fourche, Donaldsonville, La.
4 Sugar Factory on Palo Alto Plantation, Donaldsonville, La.
5 Sugar Factory on Greenwood Plantation, Thibodaux, La.
6 Bridge at Napoleonville, La.
7 Sugar Factory, Westfield Plantation, Paincourtville, La.
8 Residence of E. P. Munson, Napoleonville, La.
9 La Fourche Refinery, Thibodaux, La.
10 Sugar Mill on E. D. White Plantation
11 Sugar Factory, Abbey Place Plantation

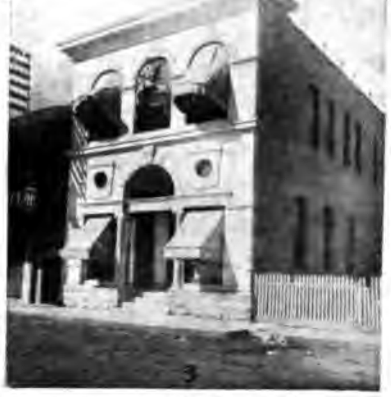
SCENES ALONG THE LA FOURCHE

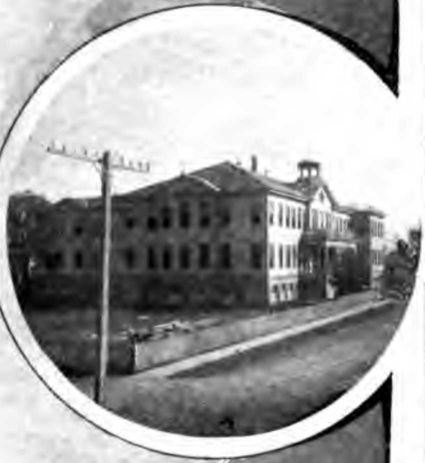


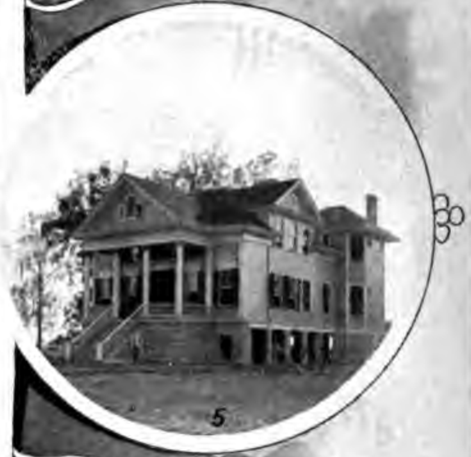
1 Locks at Plaquemine 3 Wilberts & Bros'. Sawmill, Plaquemine 5 Houmas Sugar Refinery, Burnside 7 Court House, Donaldsonville
2 Residence of James A. Ware 4 W. P. Miles' Residence, Burnside 6 Bird's-Eye View of Houmas Plantation 8 Vega Building, Donaldsonville
9 Residence of W. J. Behan 10 Plant of the Donaldsonville Ice Co.

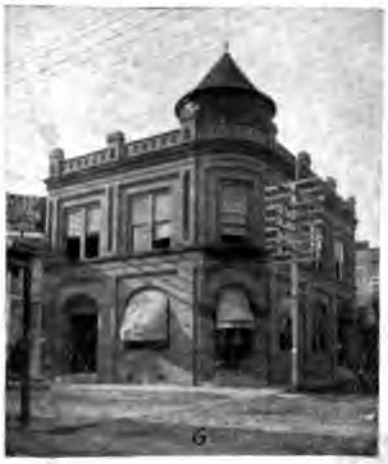


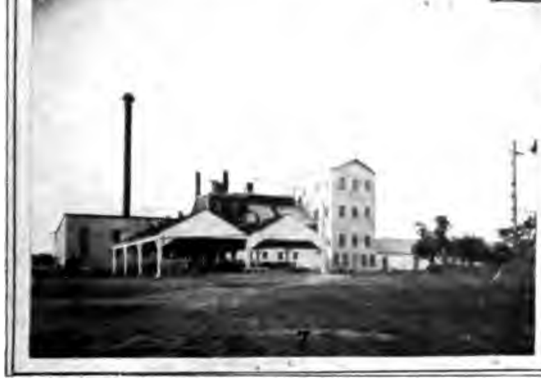


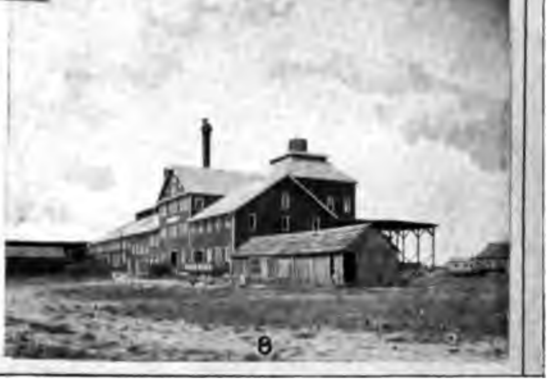






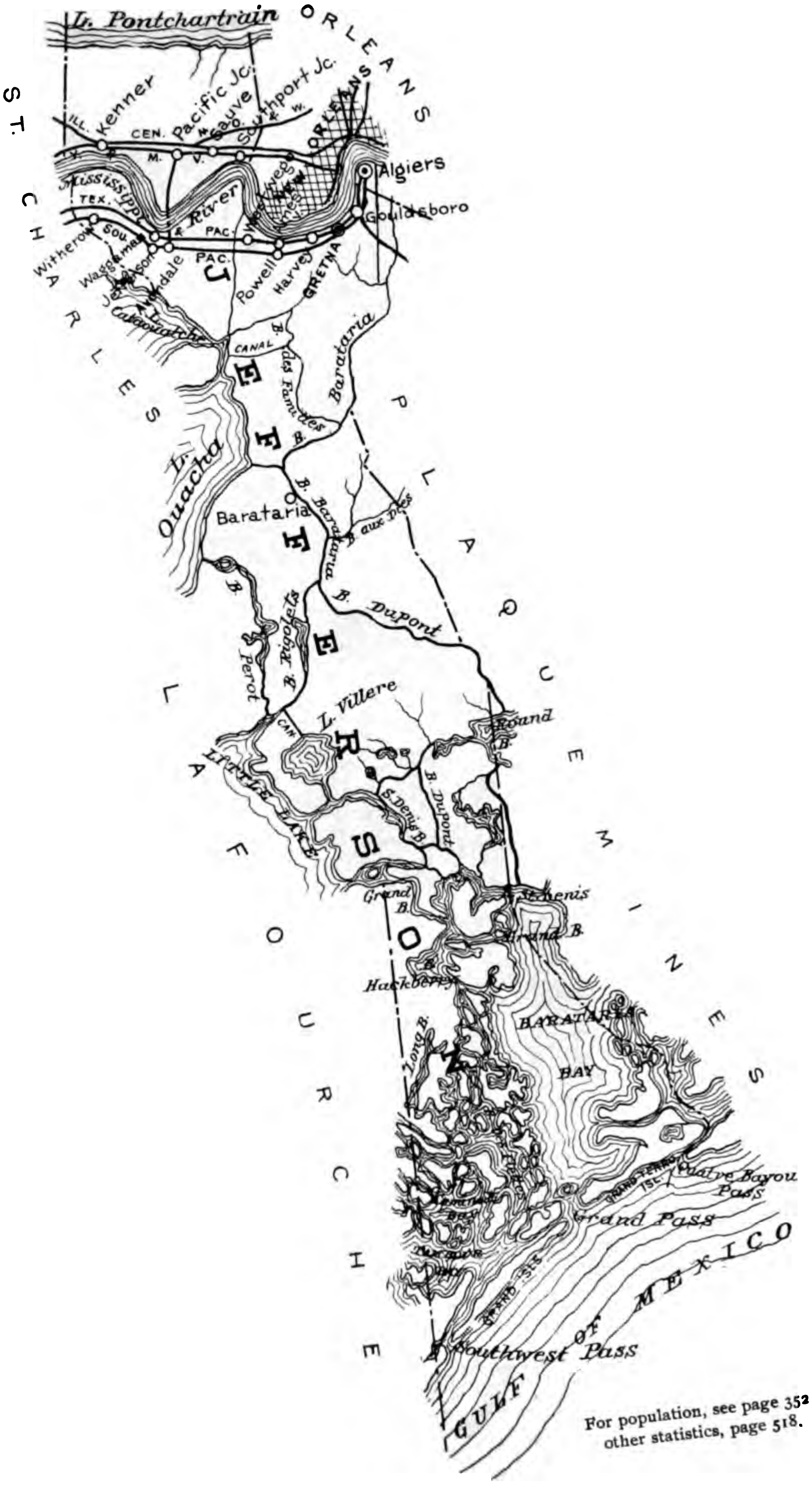




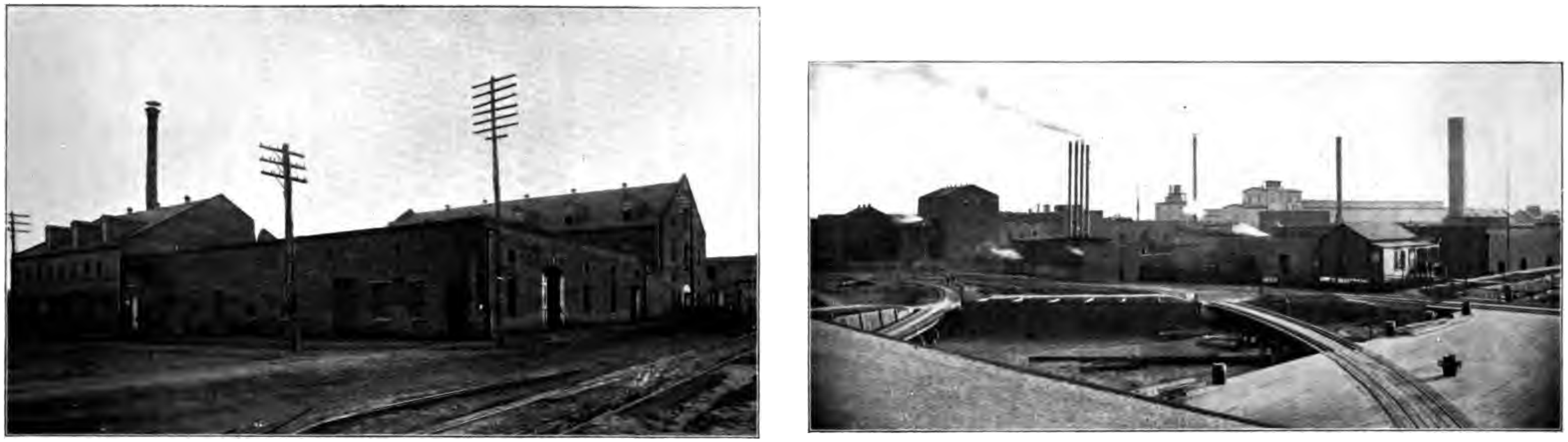


1 Acadia Sugar Factory
2 Court House and Water Works, Thibodaux
3 Bank of La Fourche, Thibodaux
4 Mt. Carmel Convent, Thibodaux
5 Residence of John T. Moore, Shriever
6 Bank of Thibodaux
7 Waubon Refinery
8 Sugar Factory, Laurel Grove Plantation

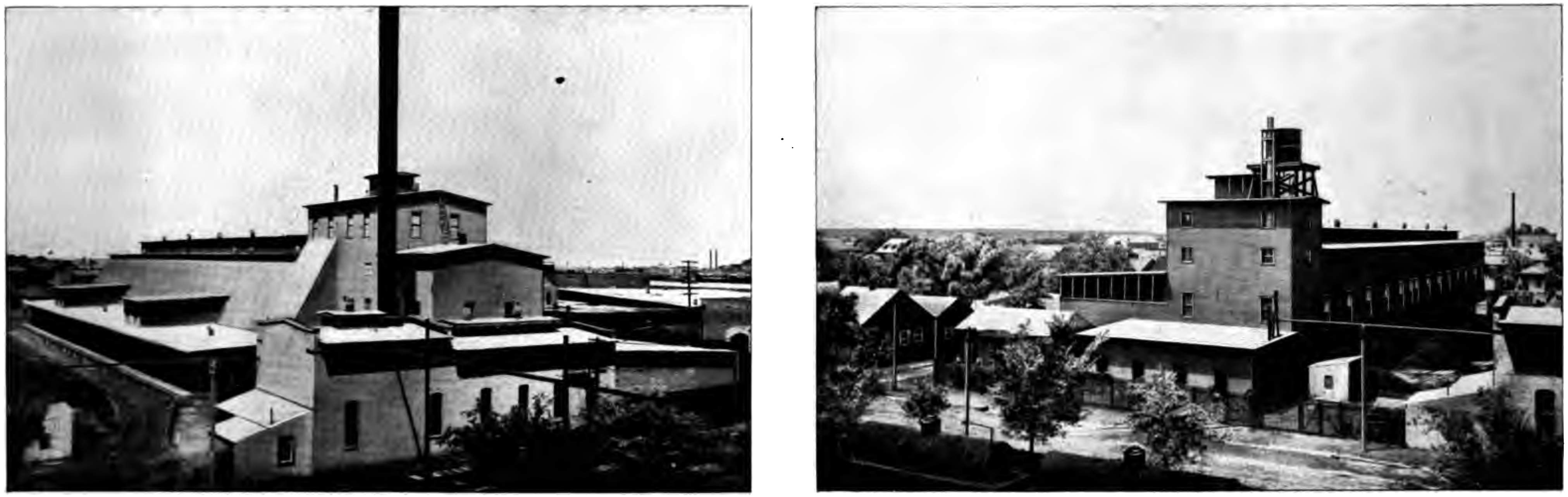
VIEWS IN AND AROUND THIBODAUX AND SHRIEVER



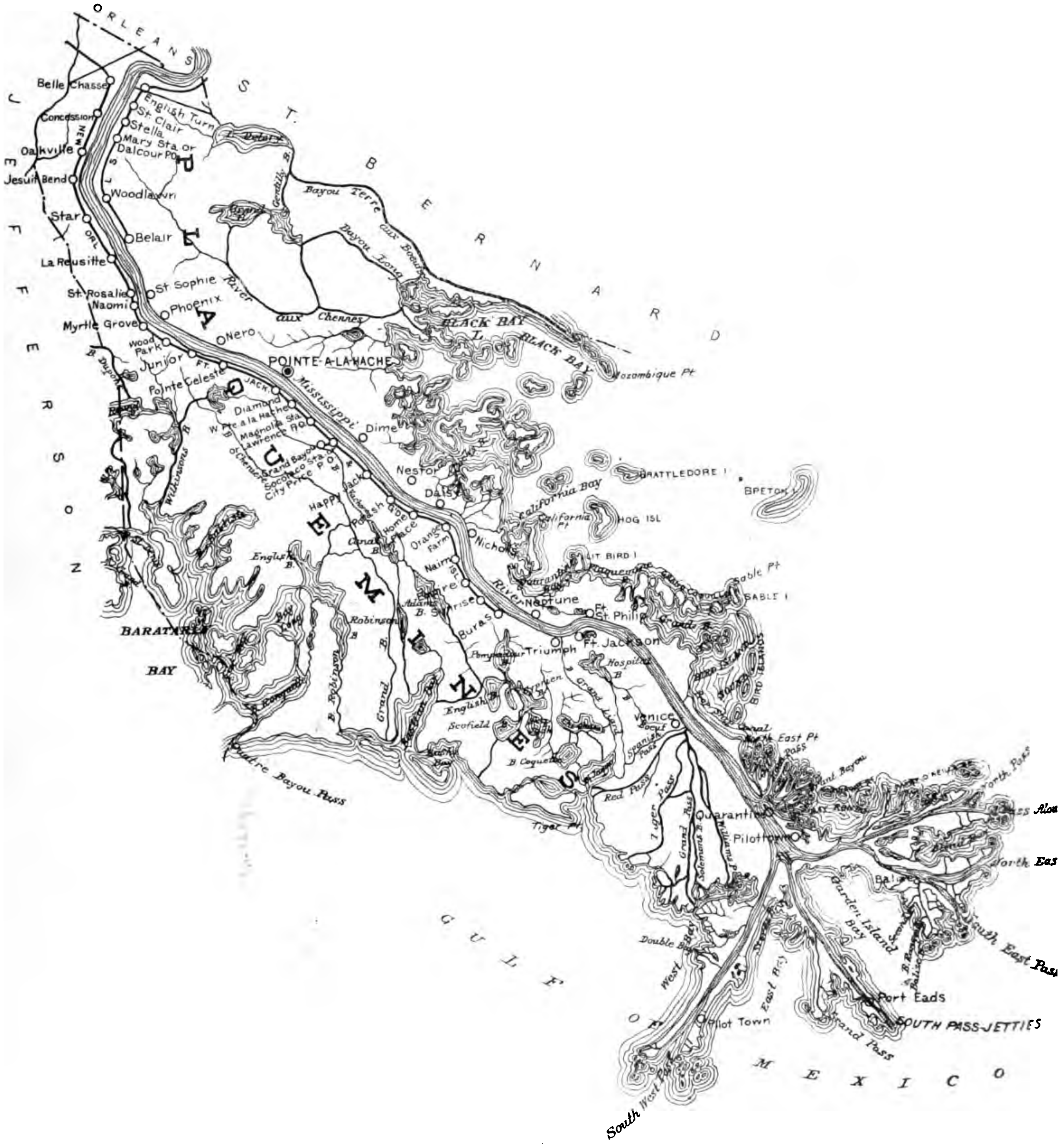
For population, see page 352;
other statistics, page 518.



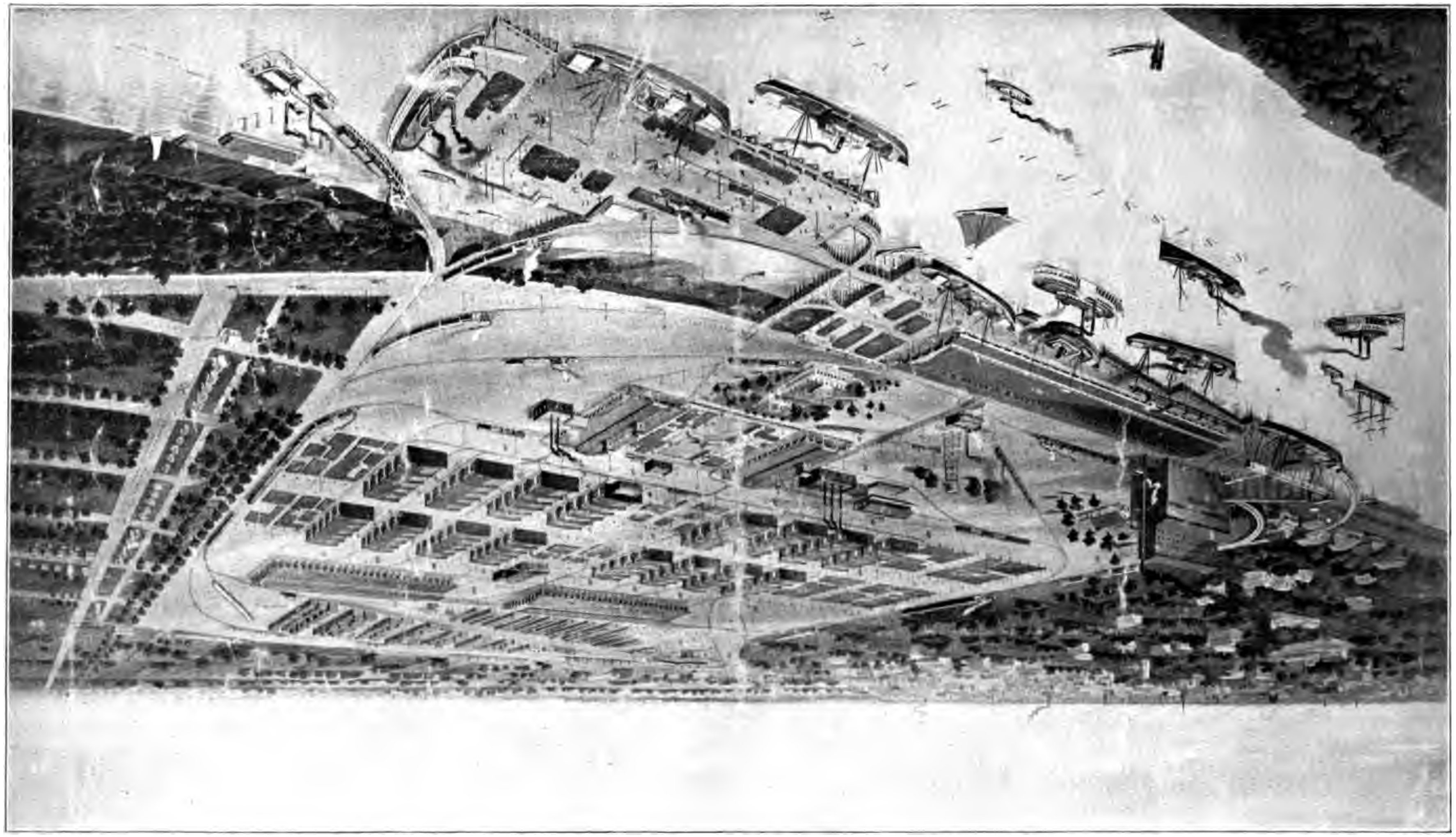
VIEWS OF PLANT OF UNION COTTON OIL CO., GRETNA, LA.



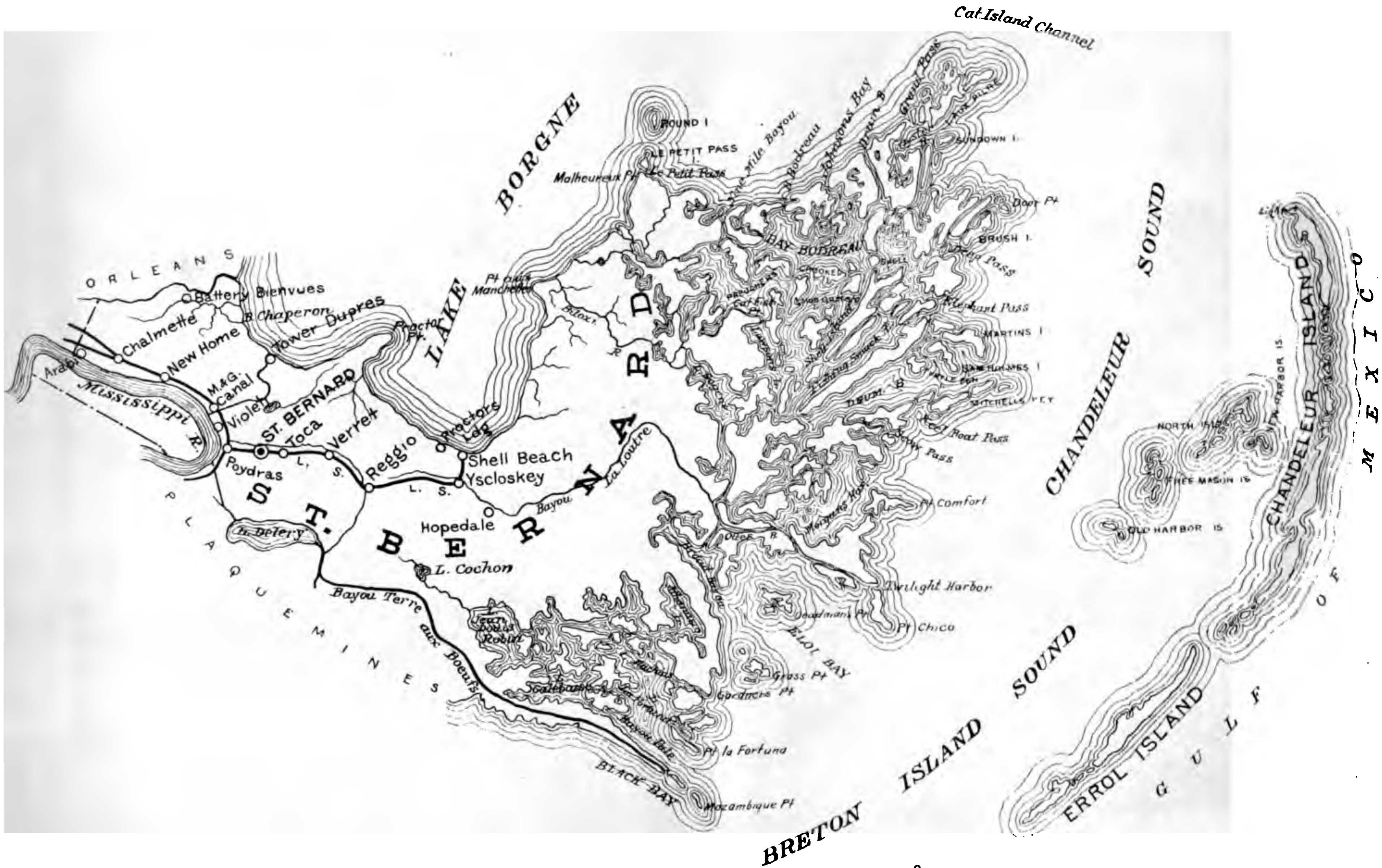
VIEWS OF NEW ORLEANS ACID AND FERTILIZER COMPANY PLANTS, GRETNA, LA.



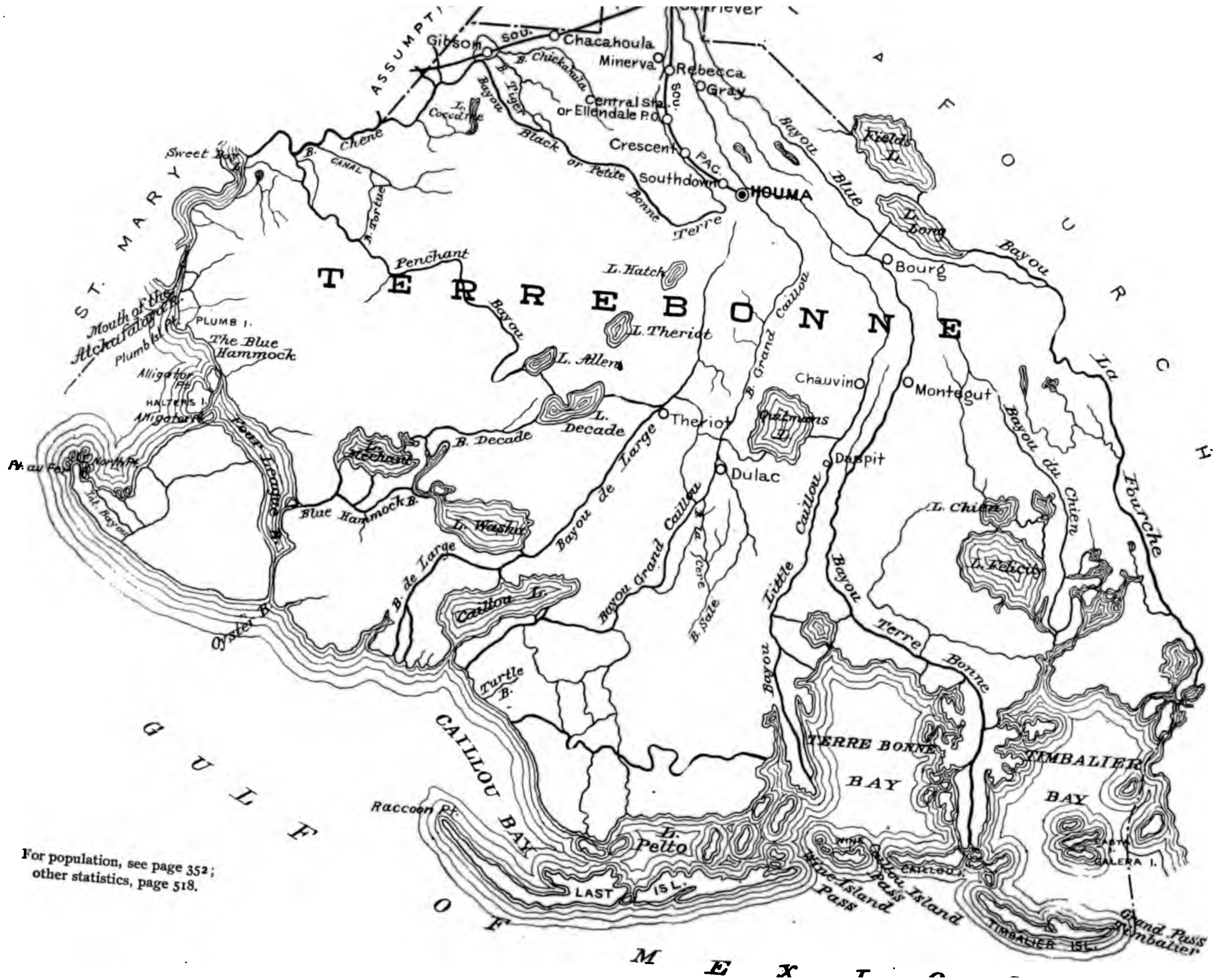
For population, see page 352; other statistics, page 518.



BIRD'S-EYE VIEW OF THE CHALMETTE TERMINALS OF THE NEW ORLEANS & WESTERN RAILROAD



For population, see page 352; other statistics, page 518.



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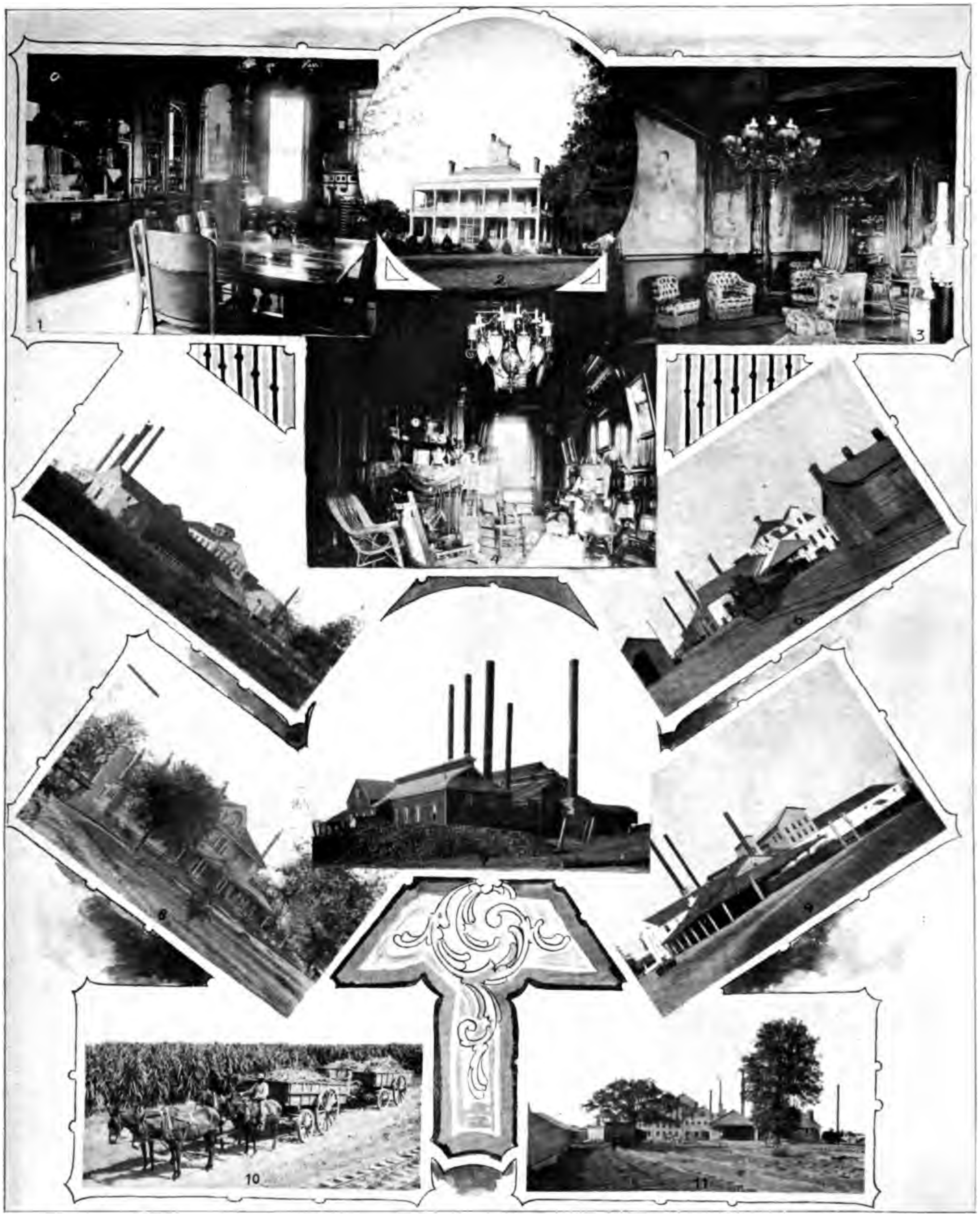


1, 2, 3, 4, Exterior and Interior Views of a Sugar Planter's Home—J. M. McBride
5. Southdown Sugar Refinery
6. Sugar Refinery, Ardoyne Plantation
7. Argyle Sugar Refinery
8. Residence of Charles McGinnis
9. Crescent Farm Sugar Refinery
10. Hauling Cane
11. Ashland Sugar Refinery

SCENES IN TERRE BONNE PARISH

THE LATE WALTER C. FLOWER

PAUL CAPDEVILLE
Mayor of New Orleans

NEW ORLEANS

BY THE LATE WALTER C. FLOWER

From the earliest period of discovery and exploration in Louisiana until the present day, the region in which the city of New Orleans is situated has felt at once the benefit of great natural advantages and the hampering influences of great natural drawbacks.

The site of the city, near the mouth of the greatest of our alluvial streams, and commanding the most direct approach to the commerce of Latin-America, is so low and level as to be ill adapted to natural drainage; and it required the exercise of engineering skill of a high order, and the expenditure of vast sums of money, to devise a system by which the heavy rainfalls common to this locality could be speedily carried off.

For the same reason, the city itself and the country tributary to it, have felt the constant need of artificial protection against the floods of the Mississippi River.

During the period of the early vicissitudes of colonial Louisiana, the minds of men were too distracted by other considerations to formulate and carry out practical schemes which would lead to a solution of the pressing problems confronting them. Indeed, there is reason to believe that at this time there was a failure to appreciate the splendid future that lay before the city.

There is now (when the wealth and prosperity of the city are based on the opportunity of connecting the domestic products and manufactures of half the continent with half of the outside world by our magnificent river, navigated by the largest ocean carriers, and by a splendid system of converging railroads) a curious interest in recalling the quaint statement of Bienville's engineer, when founding the city in 1718, that the controlling motive in the location was the opportunity of a large and profitable trade with the savages in the back country, by way of Lake Pontchartrain and the Bayou St. John, with a four-foot bar at its mouth. It did not occur to him that he was seated in the doorway of a continent, nor could he foresee the network of iron roads, traversing the country in every direction, and competing, as freight carriers, with the greatest rivers.

The opening decade of the present century witnessed two achievements, one of American statesmanship, the other of American inventive genius, both destined to have far-reaching effects upon the fortunes of the infant city. In 1803, the envoys of Thomas Jefferson consummated the purchase of Louisiana from Napoleon. In 1807, the "Clermont" of Robert Fulton, made its trial trip on the Hudson, the first steamboat on American waters.

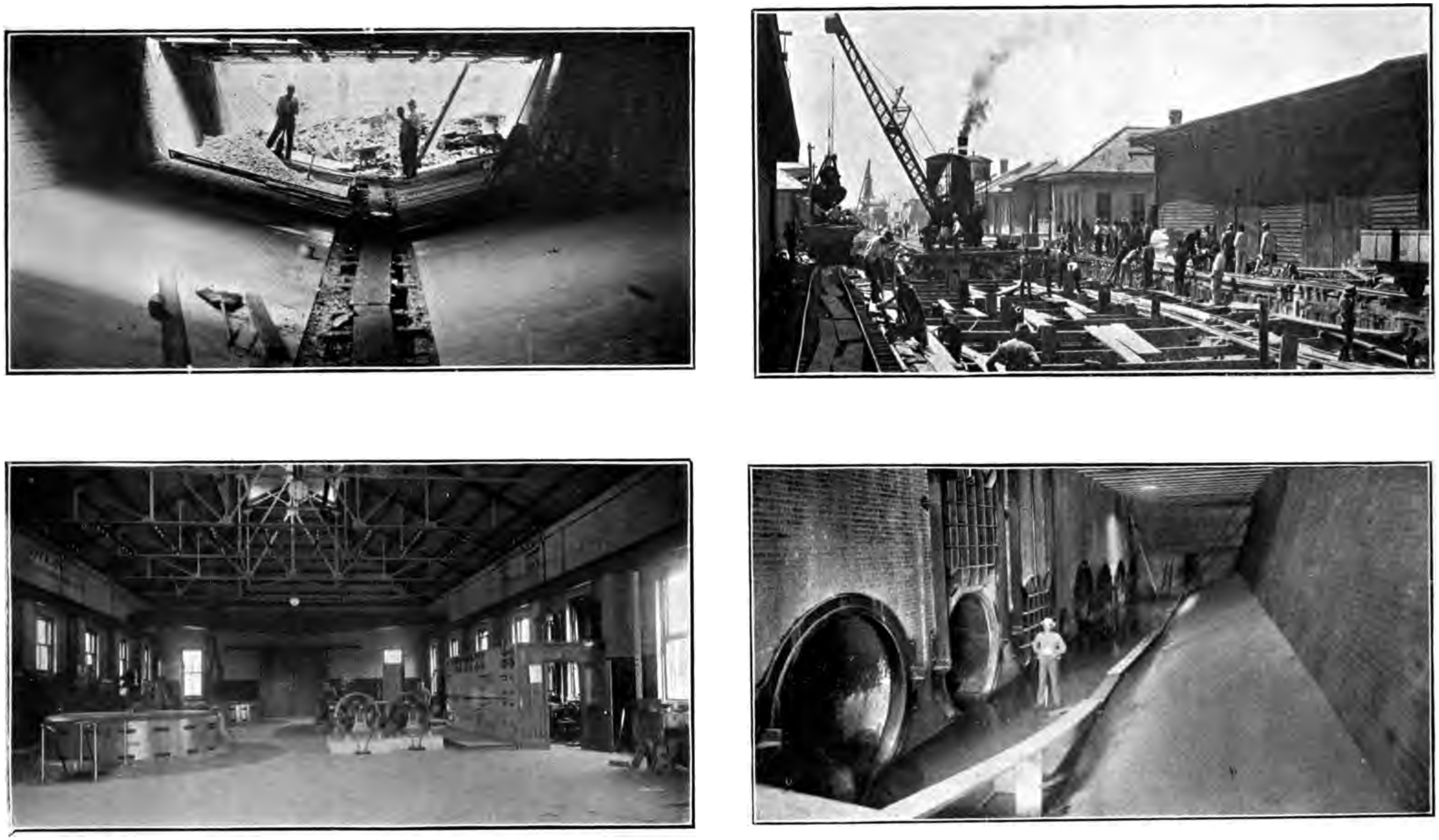
A few years before, Eli Whitney had given to the world the invention of the cotton gin, and Etienne de Bore had solved the problem of the successful manufacture of sugar from cane juice.

Thus the new territory entered the family of American commonwealths under bright auspices, and its early progress justified the hopes of the future greatness of New Orleans, which, according to one of her historians, was at this period not only appreciated, but exaggerated, by even the most sagacious minds.

In 1840, only New York, Philadelphia and Baltimore surpassed us in population. With the rapid development of ocean steam navigation, a new impulse was given to the commercial energies of our people, but here we felt nature's handicap. The character of our great alluvial stream is such that with the increased draft required by the largest steam vessels, a proper depth can be maintained at the mouth of the Mississippi only by artificial means.

In 1852, a board of officers appointed by the War Department recommended as means of securing deep water (1) stirring up the bottom by suitable machinery, (2) dredging by buckets, (3) jetties in Southwest Pass, (4) closing lateral outlets, and (5) constructing a ship canal. A depth of 18 feet was secured by the first plan and maintained until the funds were exhausted.

Under the next appropriation (1856) an abortive



SOME VIEWS ON THE INSTALLATION OF A NEW SEWAGE SYSTEM AT NEW ORLEANS attempt was made to apply the plan of jetties to Southwest Pass; but a depth of 18 feet was secured. by dredging and scraping.

The greatest depth attained before the completion of the Eads jetties in 1879 was 20 feet. The least depth since their completion has been 25 feet. The recent phases of the vital problem of deep water for our great ocean carriers are familiar to the public.

The guaranty of a sufficient depth at the mouth of the Mississippi removes one great menace to the city's prosperity.

With the almost insurmountable obstacles to natural drainage already mentioned, and with nearly two centuries' persistent violation of the elementary laws of sanitation, New Orleans has borne the inevitable penalty of wasting epidemics which have checked her progress and neutralized the many natural advantages which she enjoys. A year after the partial success of the crude effort toward deep-water navigation already referred to, occurred the great epidemic of 1853. A year before the completion of the Eads jetties, came the epidemic of 1878. Then, for nearly twenty years we were lulled into security by continued immunity from the disease, until in 1897 and 1898 the mild visitations of those years stirred to frenzy the people of the surrounding country, tributary to the city's trade and commerce; and partly through genuine fear, partly through adroit use of our extremity as their opportunity, enabled some of our ambitious neighbors to divert a substantial part of the traffic which was rightfully ours.

Then our people were brought face to face with the necessity for prompt and vigorous action for the removal of the stigma which had so long rested upon the city. During the closing months of the year 1898, the movement for sewerage, drainage, and the purchase and extension of the existing waterworks plant, took definite form. At a special meeting between members of the council and other officials of the city government, the scheme of a special tax levy for those purposes was broached. It was approved at this preliminary meeting, and laid before the public. Such obstacles as are incidental to great enterprises of its kind were gradually overcome; the legal and constitutional problems presented were solved, and the ordinance of the City Council designed to carry out the project was submitted for ratification to the Legislature of Louisiana at an extra session held on August 8, 1899. At that session the Legislature ratified the ordinance passed by the municipal council and provided for the organization of a sewerage and water board so constituted as to be beyond the reach of political influence and control.

The General Assembly also reported a constitutional amendment to be submitted to the people at the general State election to be held in April next, confirming the municipal and legislative action, and giving constitutional sanction to the public improvement bonds to be issued for the execution of the proposed work. All preliminaries for the bond issue, and general organization of the Board are now being made, and after the election in April the work will be pushed vigorously. Our design is to complete the whole drainage, sewerage and new filter water plant in five years. These great works accomplished, we believe that yellow fever and other epidemic diseases will be forever banished from New Orleans.

With the city thoroughly sewered and drained, and provided with an adequate water system under municipal control and under the management of a non-partisan, non-political Board, as contemplated in the legislative act; with the Mississippi River and her levees under the control of the national government, and deep water at the river's mouth assured, a future opens up for New Orleans almost undreamed of to-day.

Situated at the gateway of a continent, at the mouth of the largest river in the world, affording a natural highway to the sea for the varied products of the fertile valleys drained by the Mississippi River and its tributaries, New Orleans is destined to be the greatest exporting port of the country. Already her exports of grain have quadrupled in the past two years, with promise of continued increase.

Her exports of cotton, rice, sugar and grain make her to-day the second export city of the United States. The increasing business with the vast territory to the southwest, with the growing South American republics and with Mexico, give promise of vast accessions to her commerce within the next few years. The completion of the Nicaragua canal is but a question of time. With a future so full of promise, New Orleans presents to the capitalist, the manufacturer, the man of business and enterprise, a field for investment and operation unsurpassed by any city on the American continent.

W. C. FLOWER,
Mayor.

Nov. 1, 1899.

LOUIS PFISTER
President Wholesale Grocers' Association

S. P. WALMSLEY,
President Cotton Exchange

D. M. KILPATRICK
President Chamber of Commerce

UDOLPHO WOLFE
President Board of Trade

F. W. YOUNG
President Manufacturers' Association

ISIDOR NEWMAN
President Stock Exchange

C. S. FOSTER
President Credit Men's Association

J. C. MURPHY
President Sugar Exchange

HENRY G. HESTER
Secretary Cotton Exchange

ROBERT M. WALMSLEY
President Drainage Commission

HENRY H. SMITH
Secretary Board of Trade

WILLIAM ADLER

A. R. BLAKELY
President Progressive Union

BERNARD McCLOSKEY
Attorney Orleans Levee Board

THE LATE JOHN CHAFFE

THE LATE J. U. PAYNE

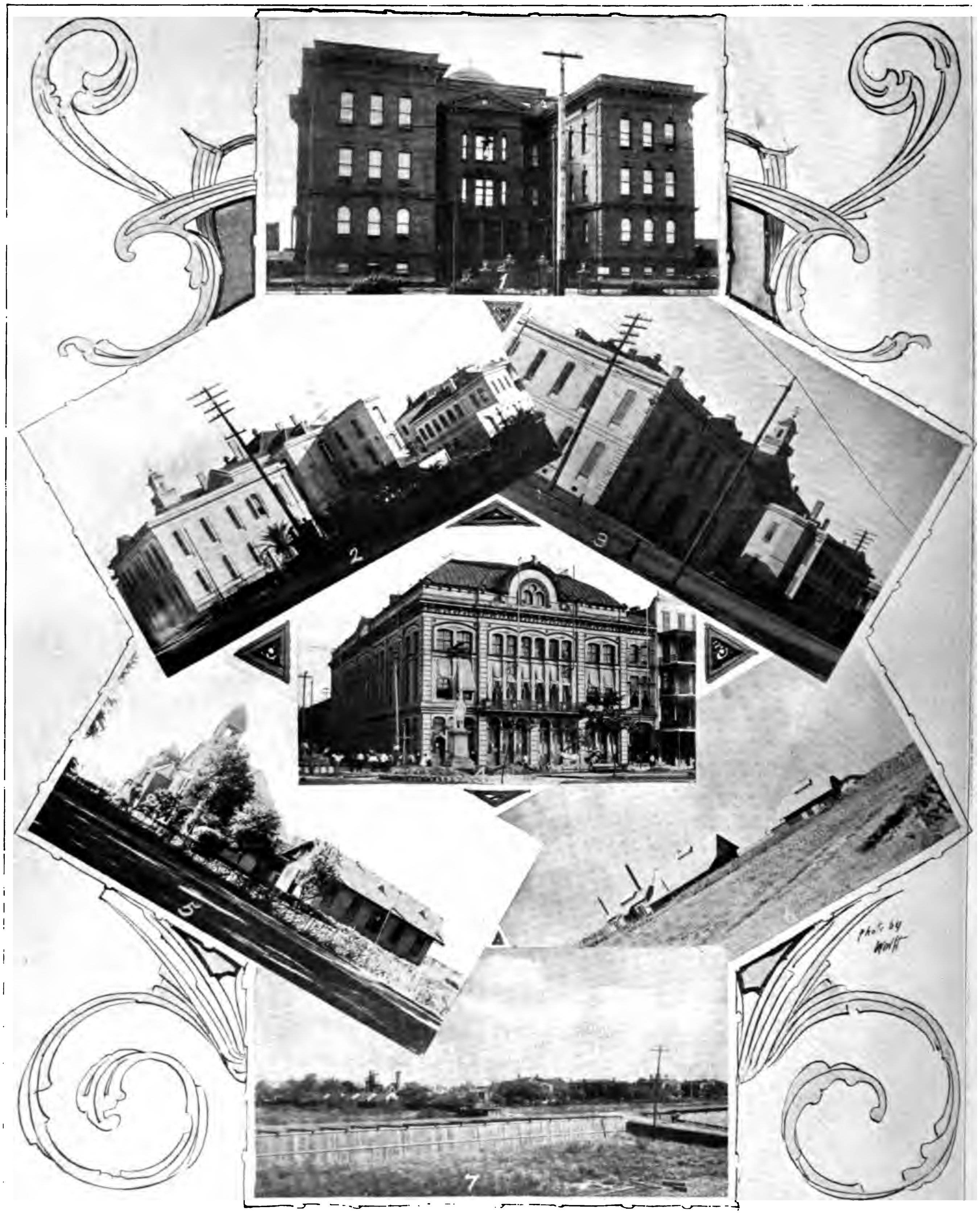
JAMES MC RACKEN

THE LATE LEON GODCHAUX

CAPT. J. W. CARLTON

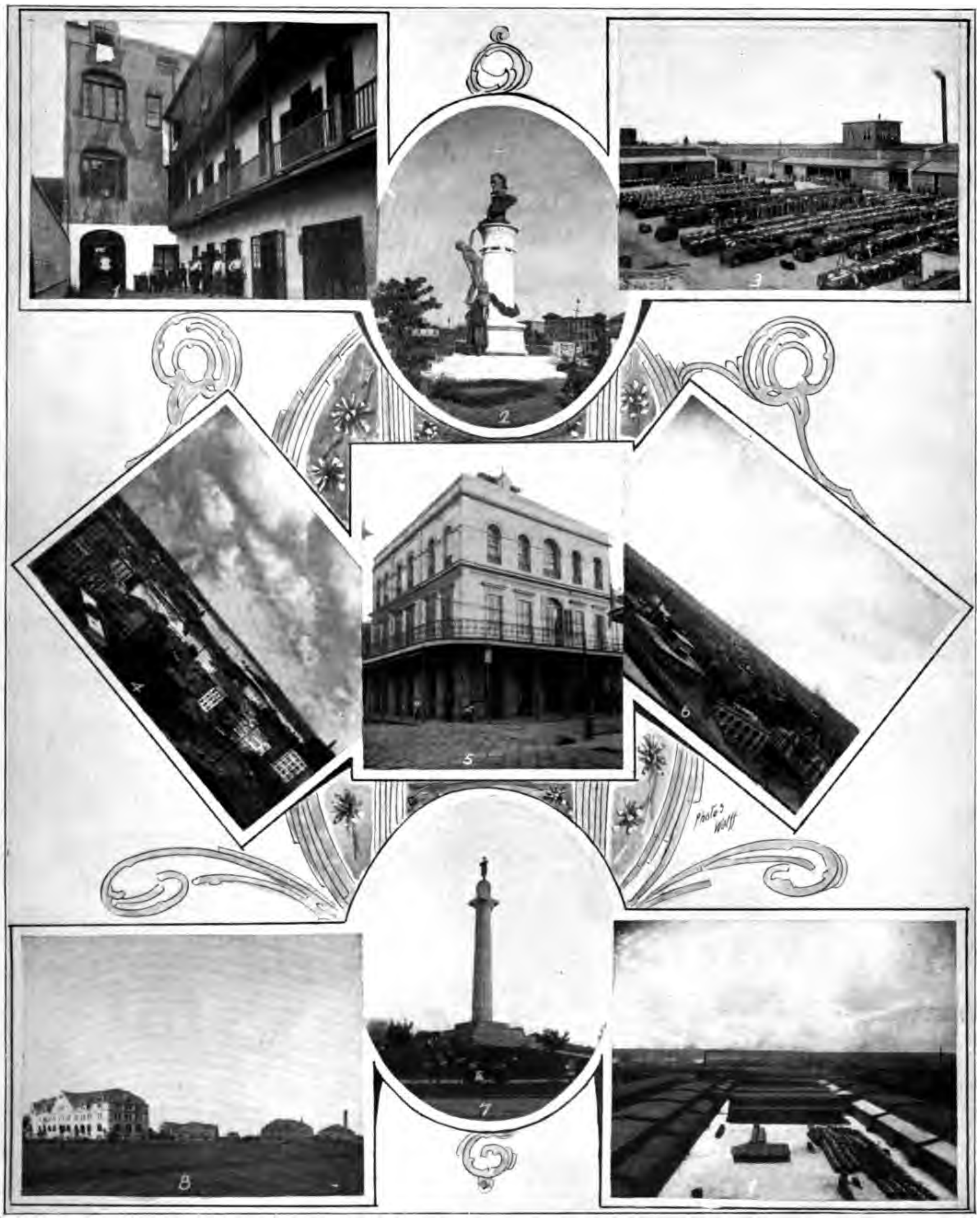
CAPT. P. A. CHARLET

LOUIS GRUNEWALD



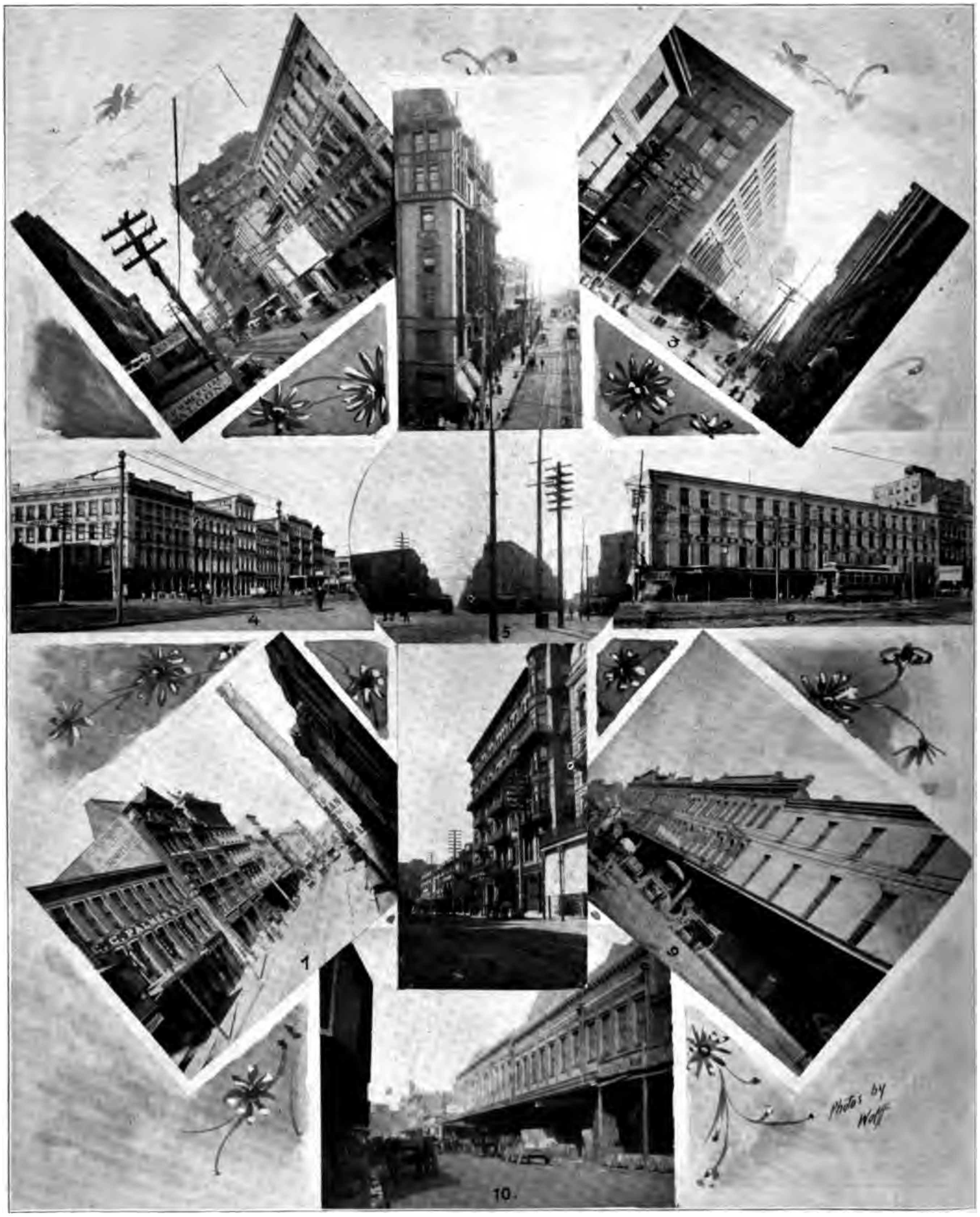
1 Richard Milliken Memorial 2, 3 Charity Hospital
4 Fisk Free Library 5, 6 Experimental Station 7 Marine Hospital

SOME OF THE PUBLIC INSTITUTIONS

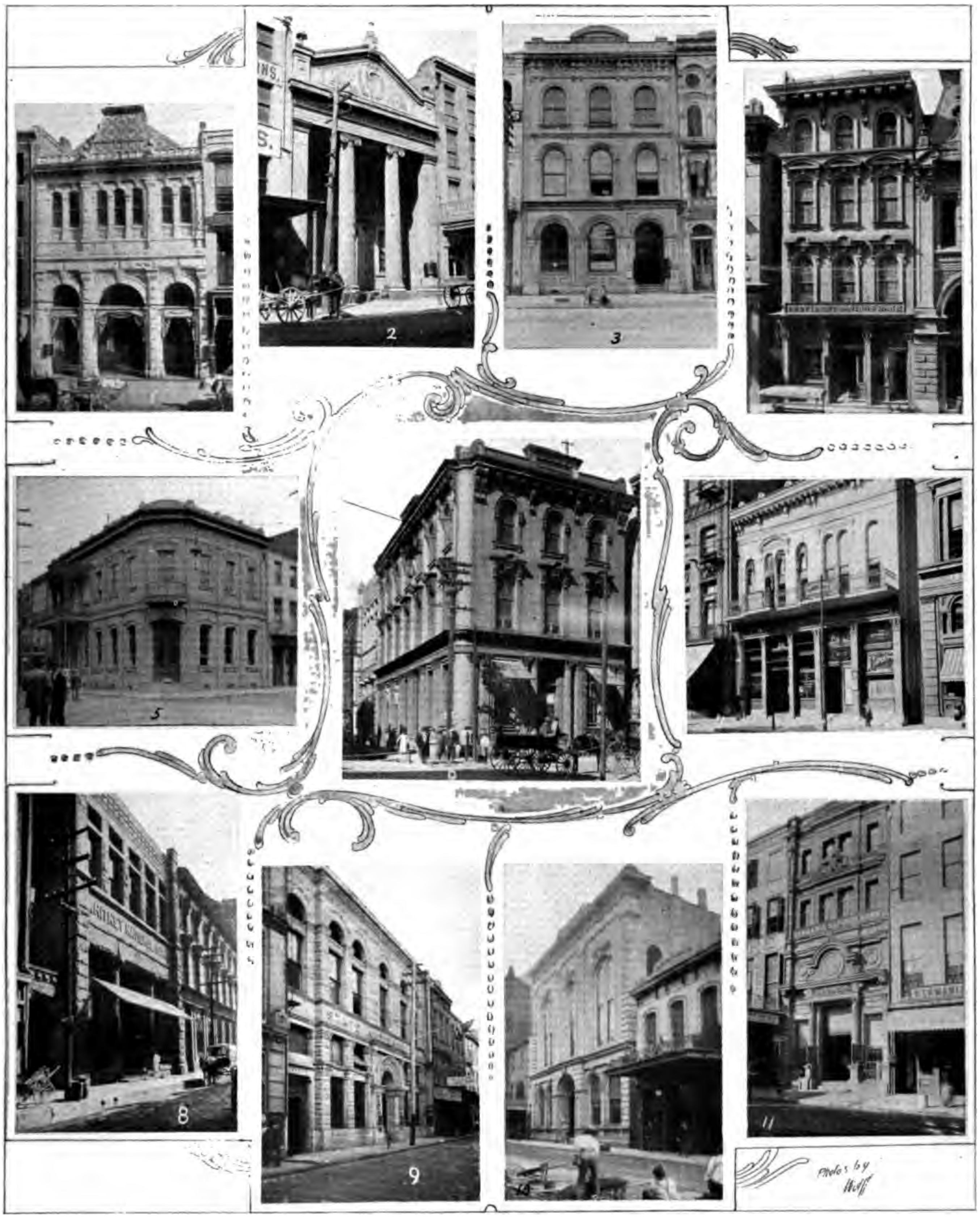


1 Old Slave Market
2 John McDonough Statue
5 A Historic Corner
3, 9 New Orleans Cotton Press
7 Lee Statue
4, 6 Bird's-eye Views from Masonic Temple
8 Tulane University

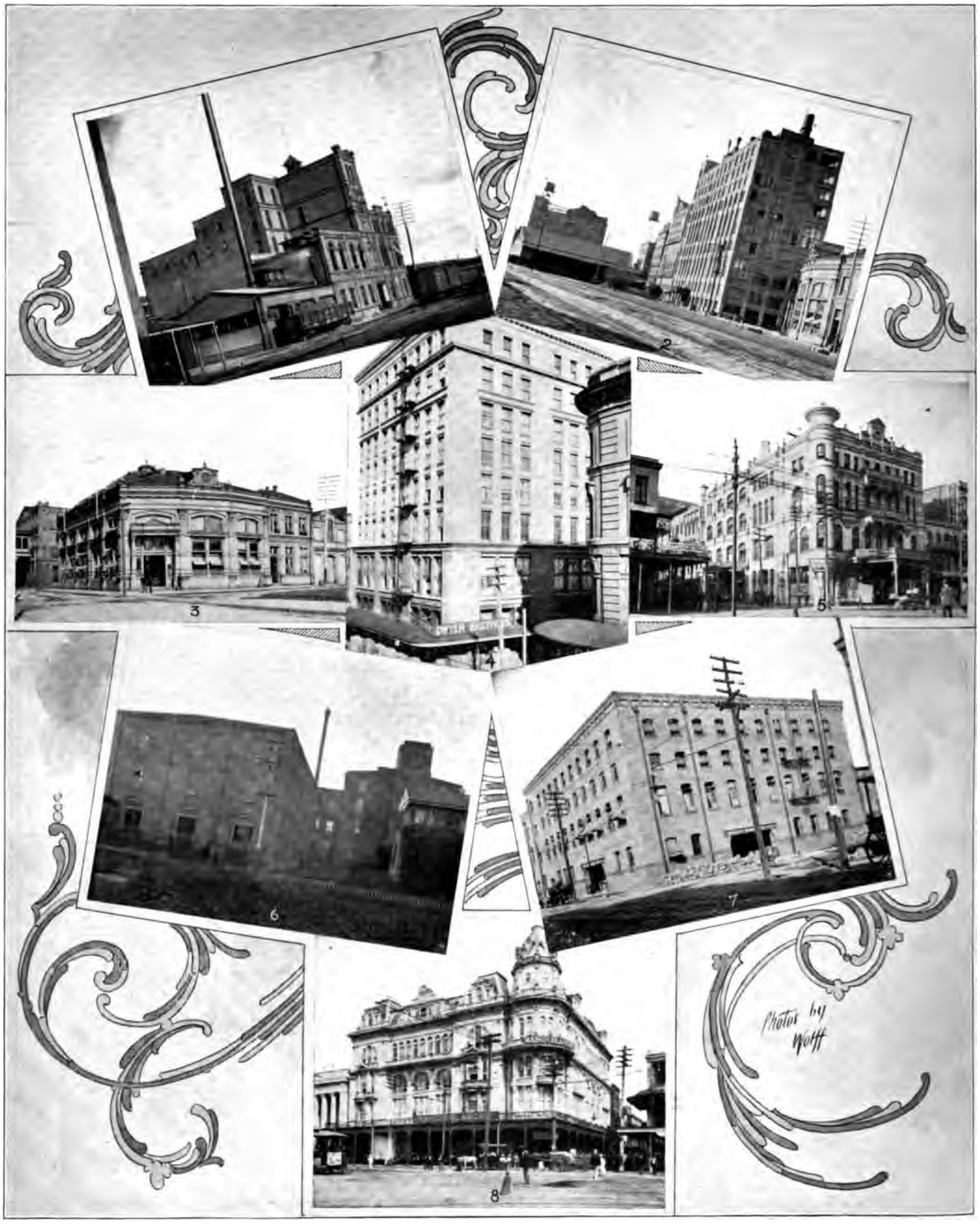
NEW ORLEANS VIEWS



STREET VIEWS OF THE COMMERCIAL SECTIONS OF NEW ORLEANS

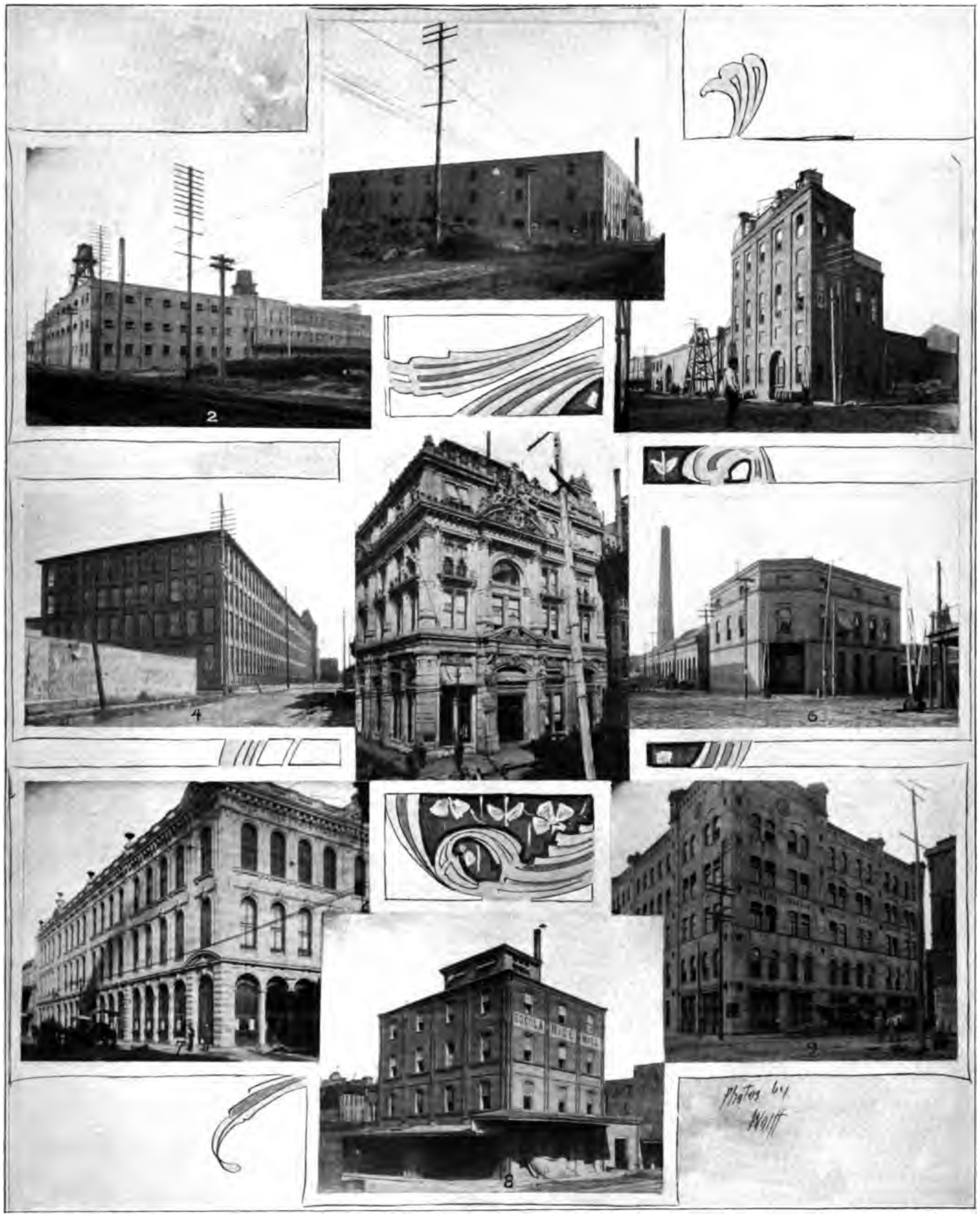


SOME OF THE BANKING HOUSES OF NEW ORLEANS



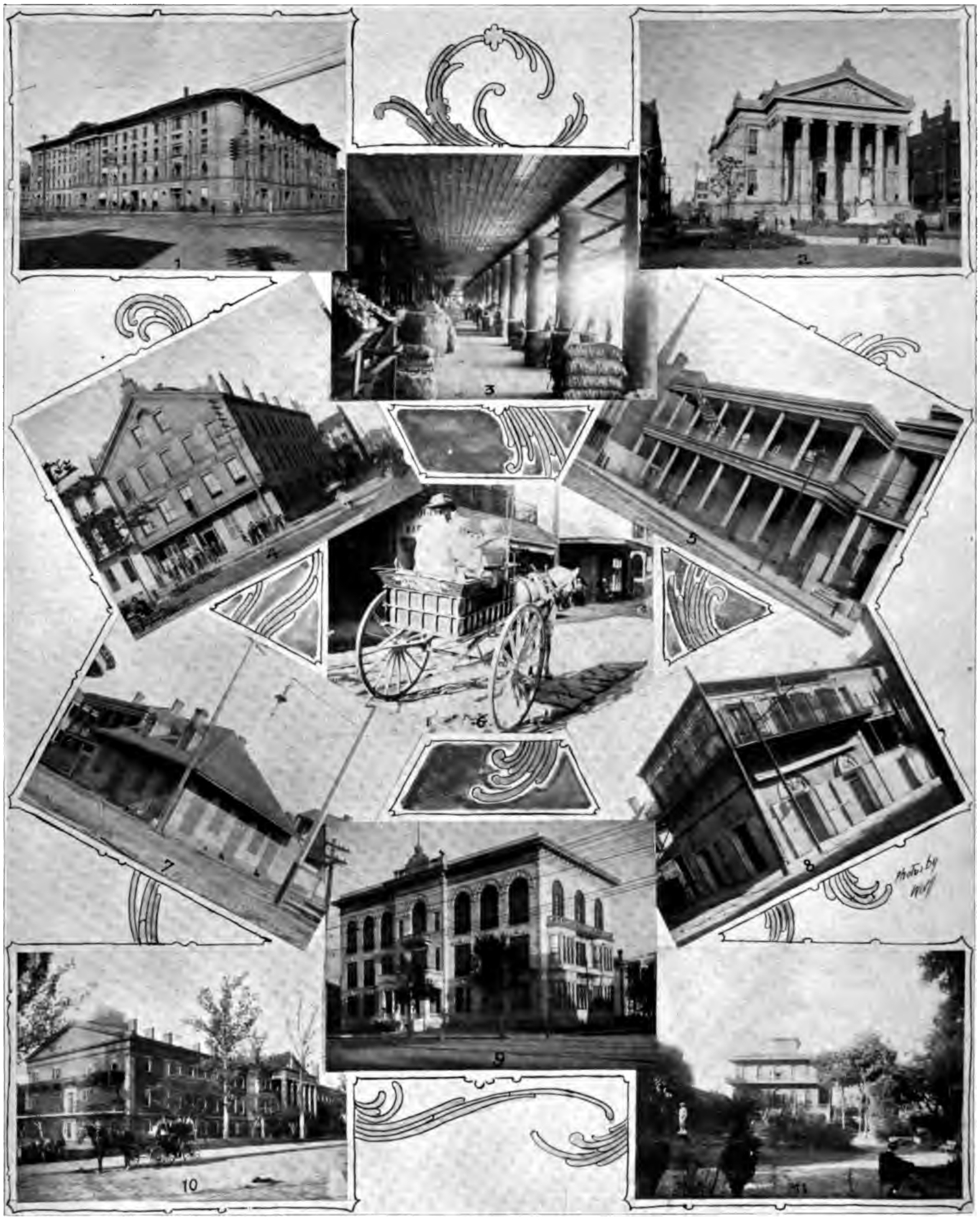
1 Jackson Brewery
2 Sugar Refineries
3 New Orleans Sugar Exchange
4 A Wholesale Dry Goods Building
5, 8 Two Fine Retail Business Buildings
6, 7 Prominent Industrial Plants

SOME BUSINESS AND INDUSTRIAL VIEWS



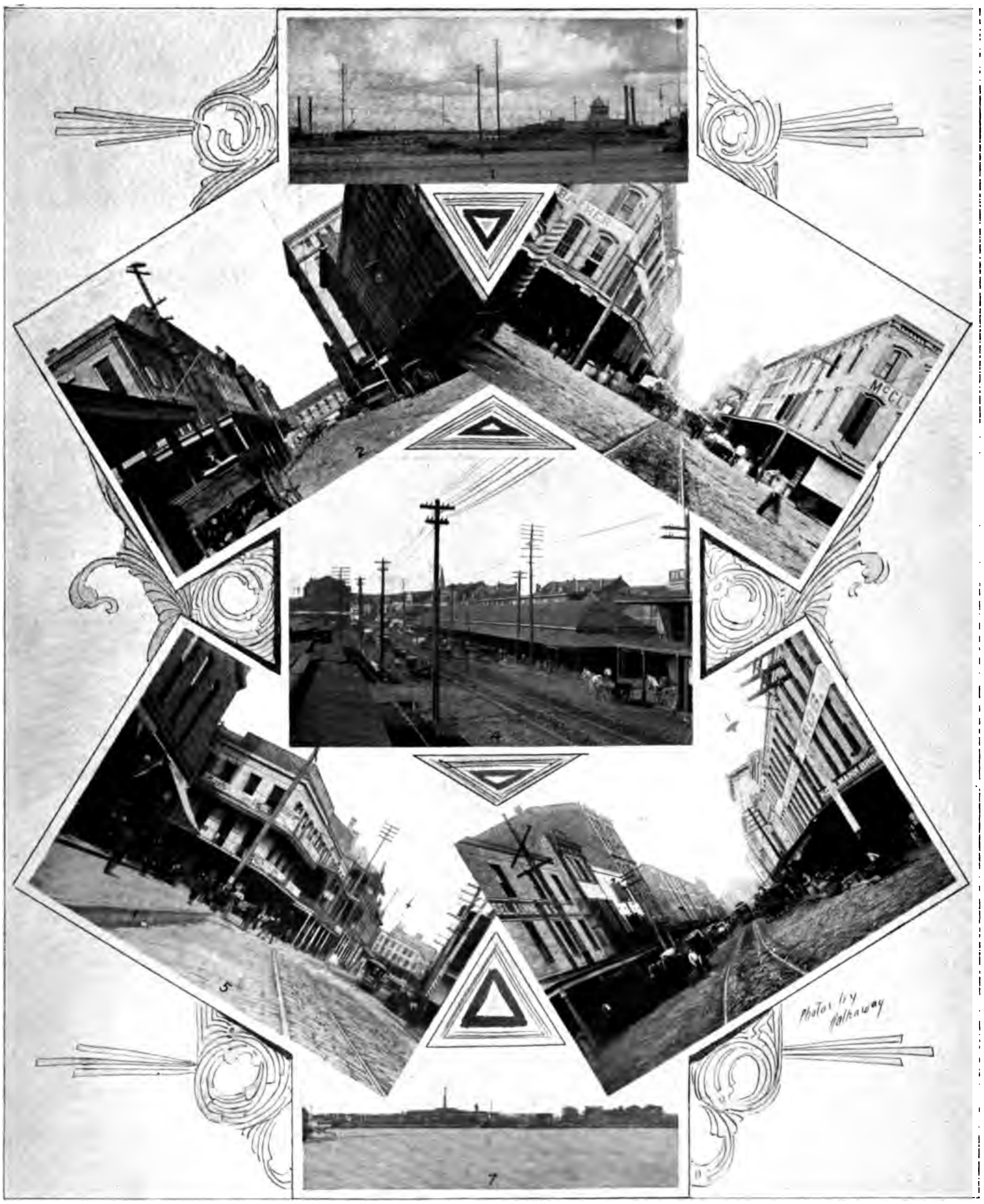
1 Brooklyn Cooperage
2 Douglas Branch American Biscuit Co.
3 Louisiana Distilling Co.
4 McGinnis Cotton Mills
5 Cotton Exchange
6 Whitney Iron Works
7 Office Building
8 Socola Rice Mill
9 Hernsheim Cigar and Tobacco Factory

PROMINENT MANUFACTURING INDUSTRIES (WITH NEW ORLEANS COTTON EXCHANGE BUILDING IN CENTER)

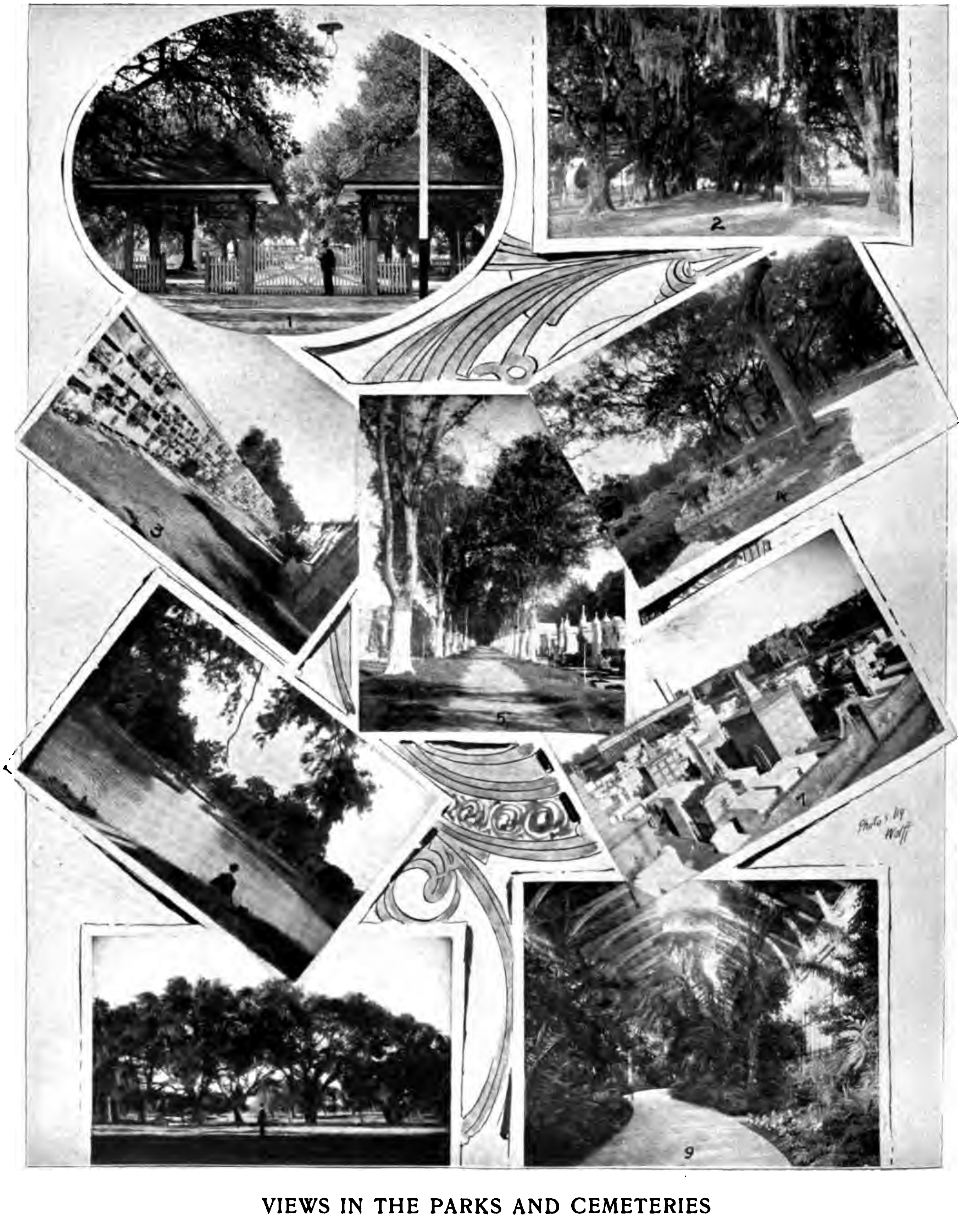


1 Custom House
2 City Hall
3 Interior View, French Market
4 Soule Commercial and Literary Institute
5 Franklin School
6 Typical Milk Wagon
7 Andrew Jackson's Headquarters
8 Old Absinthe Cafe
9 Harmony Club
10 United States Mint
11 Louisiana Jockey Club

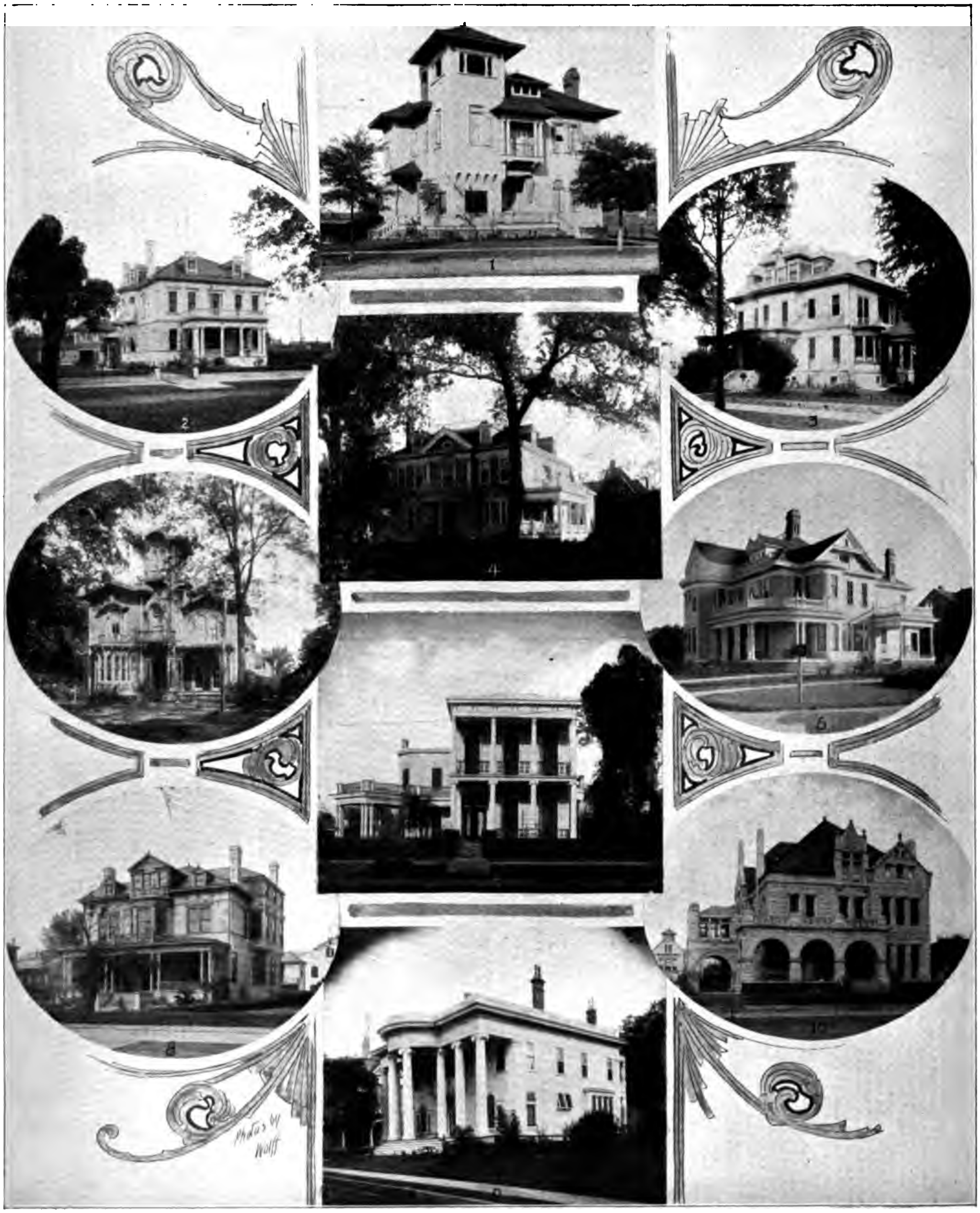
GENERAL VIEWS, NOTABLE AND PUBLIC INSTITUTIONS.



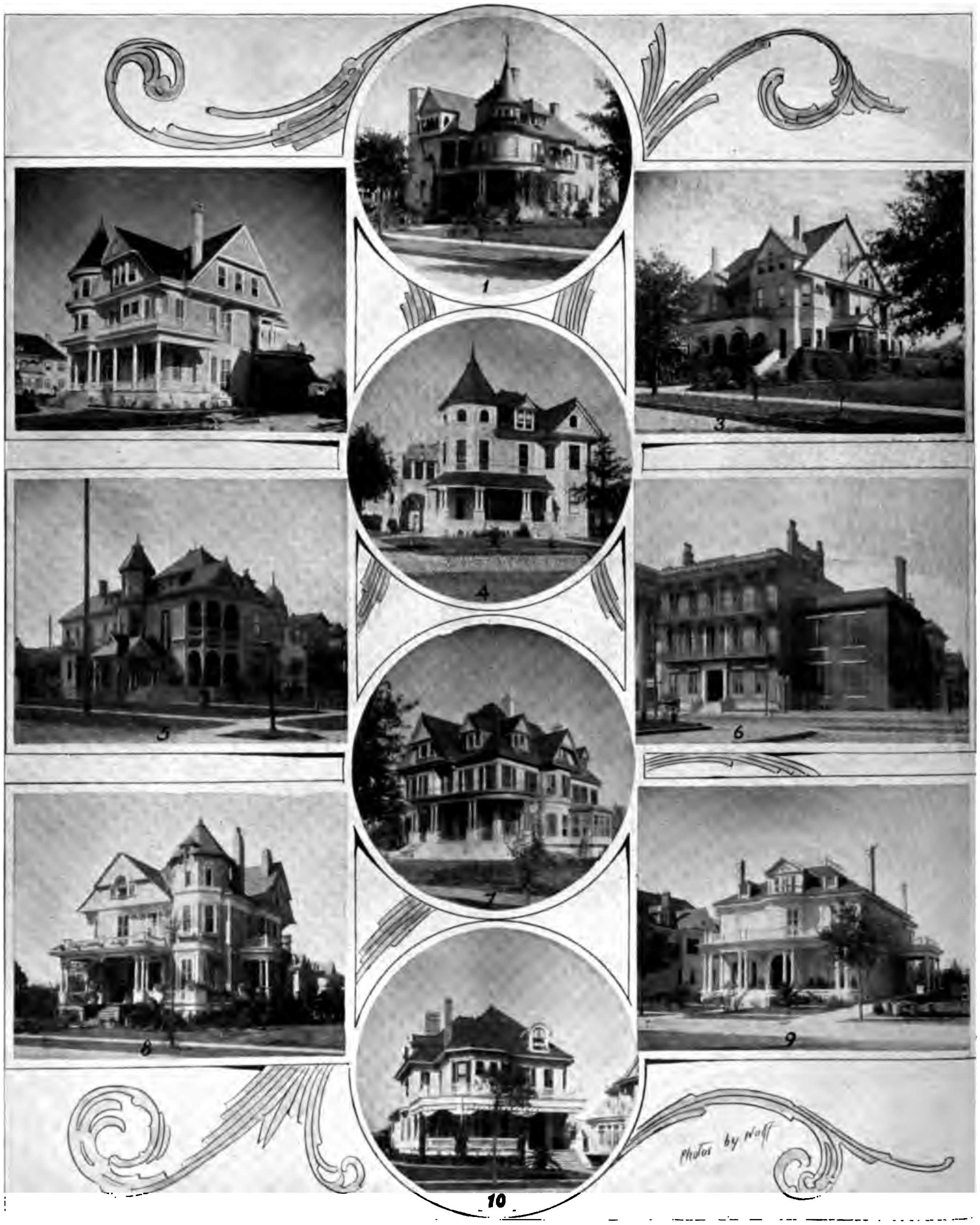
SOME STREET VIEWS, WITH THE FRENCH MARKET IN THE CENTER



VIEWS IN THE PARKS AND CEMETERIES

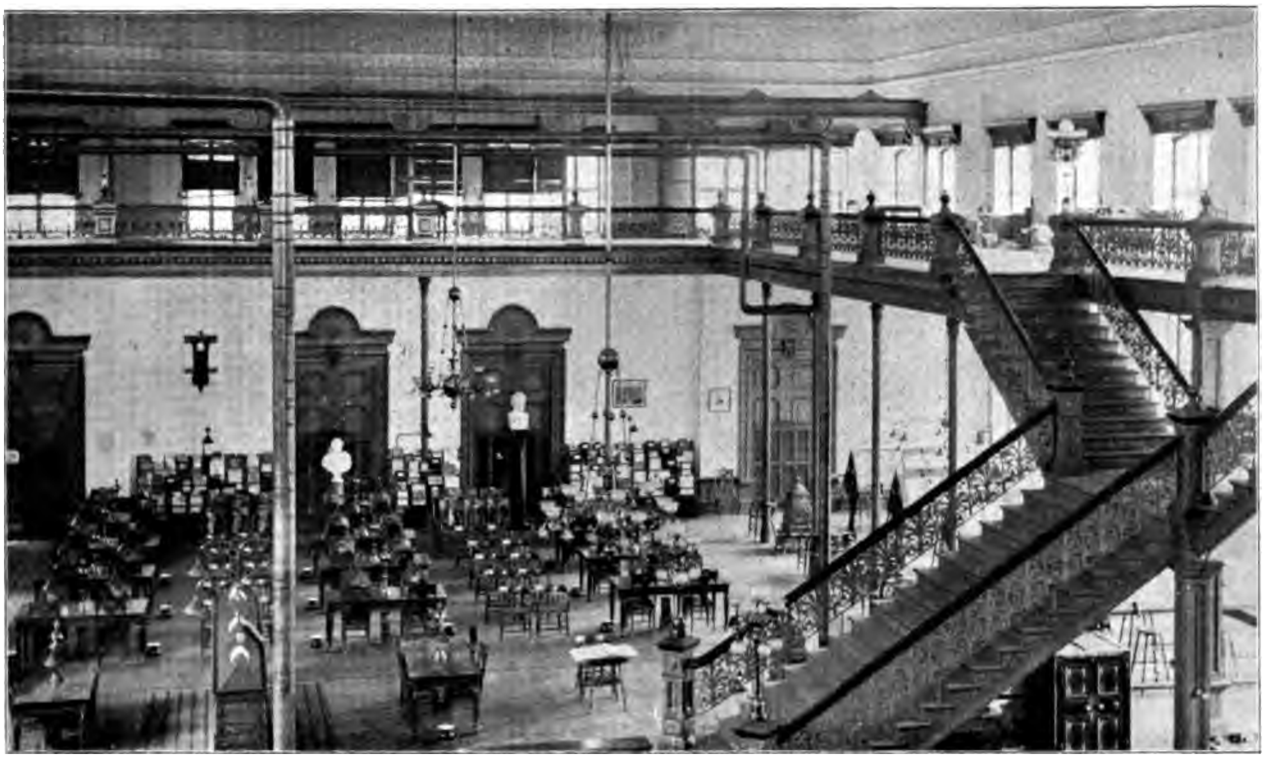


SOME TYPES OF RESIDENCES, NEW ORLEANS, LA.

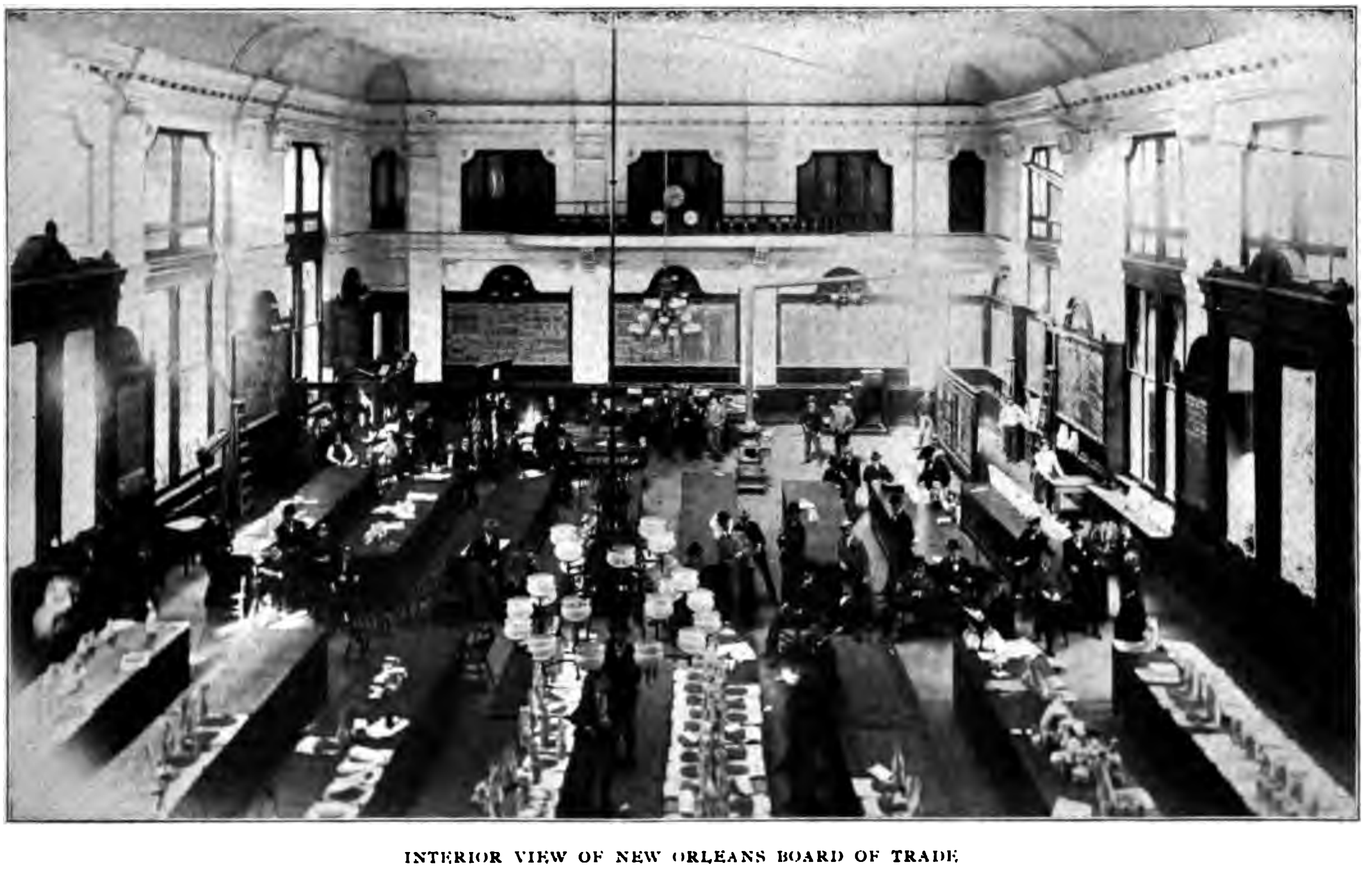


Photos by Wolff

SOME TYPES OF RESIDENCES, NEW ORLEANS, LA.

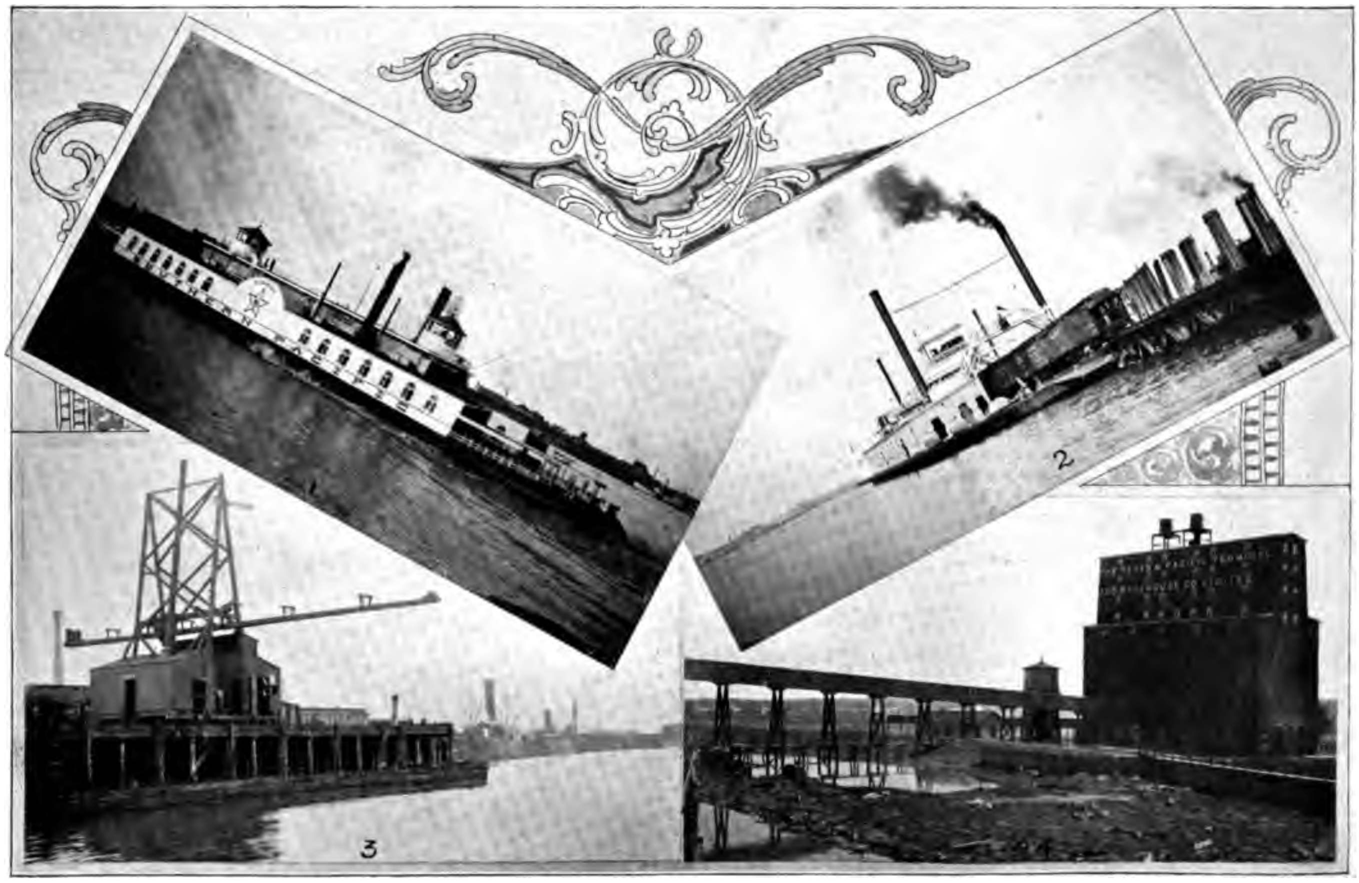


INTERIOR VIEW OF THE FISK FREE LIBRARY



INTERIOR VIEW OF NEW ORLEANS BOARD OF TRADE

THE FERRY BETWEEN NEW ORLEANS AND ALGIERS



1 Southern Pacific Transfer Boat
2 Texas Pacific Transfer Boat
3 Southern Pacific Coal Elevator
4 Texas Pacific Warehouse and Elevator

NEW ORLEANS AS A MANUFACTURING CITY

BY J. A. BLAFFER, SECRETARY NEW ORLEANS PROGRESSIVE UNION

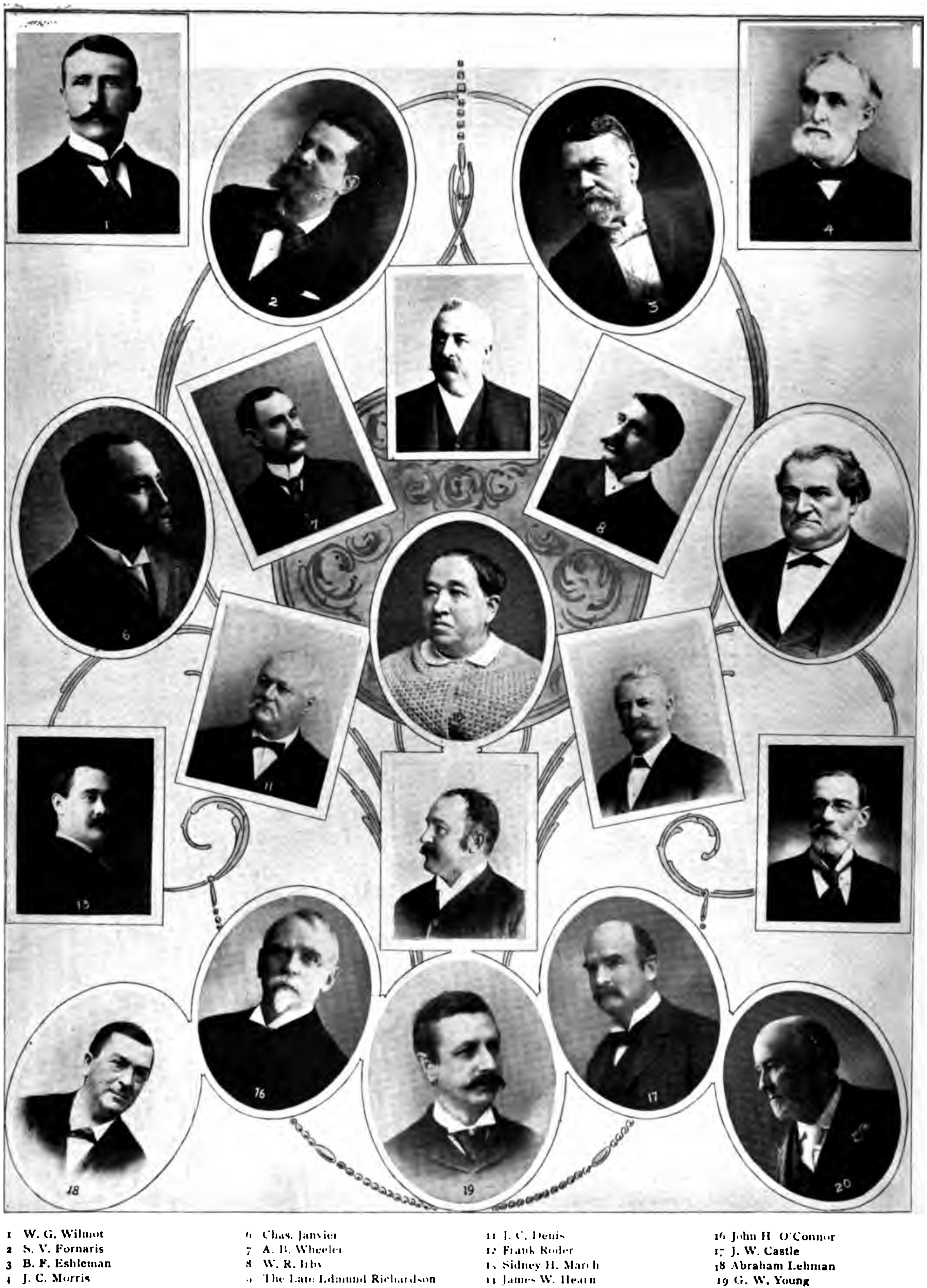
J. A. BLAFFER

New Orleans offers many advantages as a manufacturing city not possessed by other cities which have forged far ahead of her in the manufacturing line. The reason for this apparent neglect of opportunity is that New Orleans is also a commercial city of large importance, and most of the attention of her money men has been devoted to commerce. Some few have invested capital in manufacturing enterprises, and they have found that it yielded good returns, and this fact has attracted other capital, with the result that the resources of this city in that line are gradually being developed.

The people of this city have begun to realize that the future hope of the city lies in making it a city of factories, and there has been an agitation along that line that promises to bring good fruit in the near future. The fact has been brought home to the people that they send away thousands of dollars for goods which they could just as well manufacture here, and save not only the profits that accrue to the distant manufacturers, but that enormous freight charge.

One of the first requisites of a manufacturing city is the nearness to a market and transportation facilities to reach that market. These requisites New Orleans possesses to a considerable degree. Having been very largely a commercial city, her merchants have made a very large part of the southern country tributary to New Orleans. Texas, Arkansas, Mississippi, Alabama, and even Florida, are regarded as the legitimate trade territory of this city, and therefore any article manufactured for general consumption in New Orleans would find a large field for disposal in these states. But not only has she this particular advantage; she has another, which is capable of enormous development. New Orleans is the nearest American port of any consequence to the new island possessions to the south, and has a steadily growing volume of trade with the countries of Central and South America. Mexico is in direct communication with New Orleans both by rail and by steamship lines. Vast quantities of manufactured articles are brought to New Orleans from the north and northwest, and shipped from here to these countries. With regular steamship lines already established, making regular trips, the entente cordiale may be said to have already been engendered in a commercial sense, and all that remains is to build the factories here and save to the people of New Orleans the enormous amounts that they pay as tribute to the manufacturing centers of the north and east. The history of the country for the past thirty years shows that it is not the producer who makes the money, but the manufacturer, and that fact has only just begun to dawn upon the Crescent City.

Now, the next requisite, we will say, is labor. If there is a city in this country which can show a better class of labor than New Orleans, its fame has not yet reached this end of the Mississippi Valley. There are all kinds to be found here, from the most skilled artisans to the cheapest kind of day labor. As a class, it is intelligent and tractable, and has not become imbued with the spirit of socialism which has so materially interfered with the efficiency of labor in some of the manufacturing centers. A



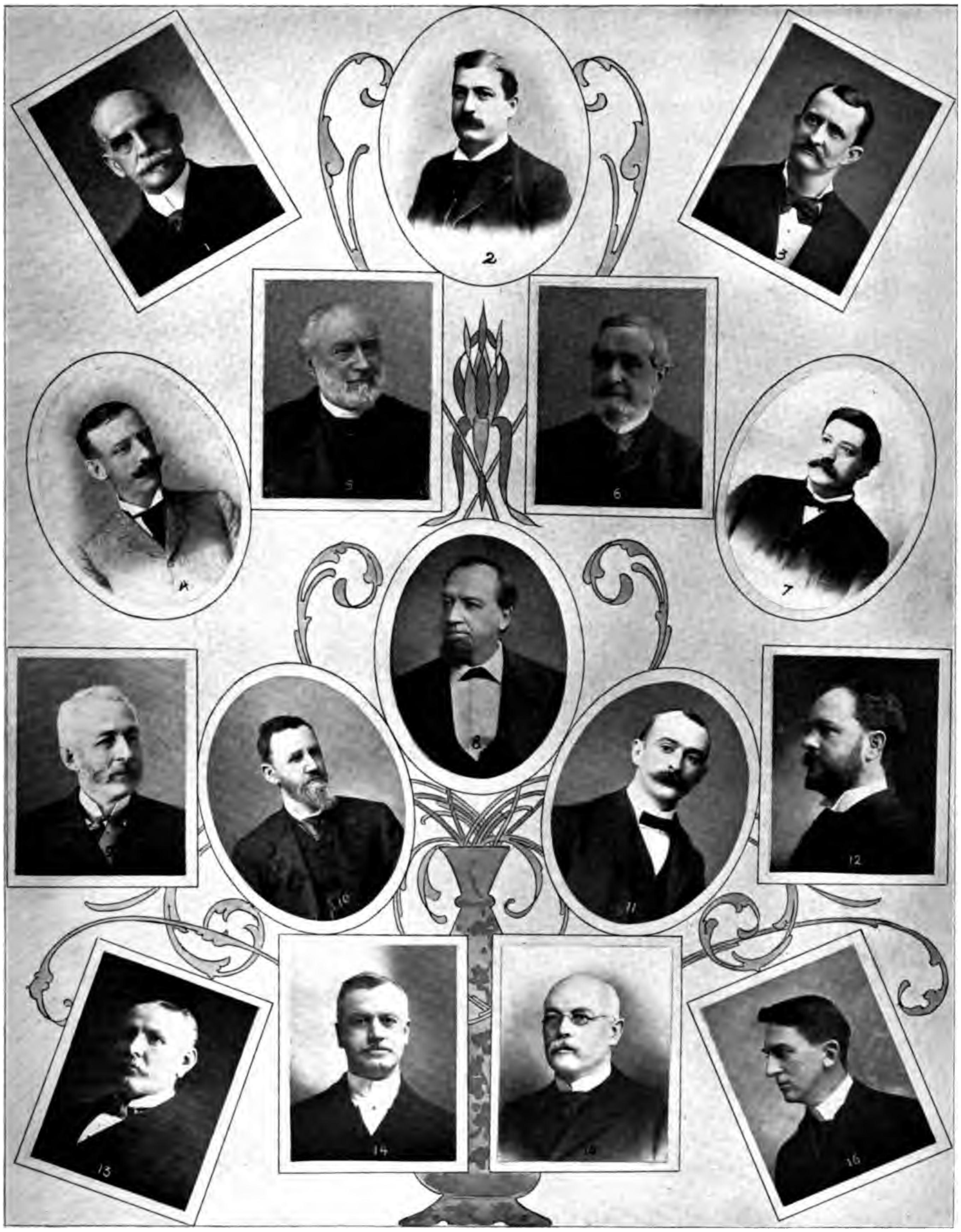
1 W. G. Wilmot
2 S. V. Fornaris
3 B. F. Eshleman
4 J. C. Morris
5 Chas. H. Schenck

6 Chas. Janvier
7 A. B. Wheeler
8 W. R. Irby
9 The Late Edmund Richardson
10 The Late Margaret Haughery

11 J. C. Denis
12 Frank Roder
13 Sidney H. March
14 James W. Hearn
15 Louis Cucullu

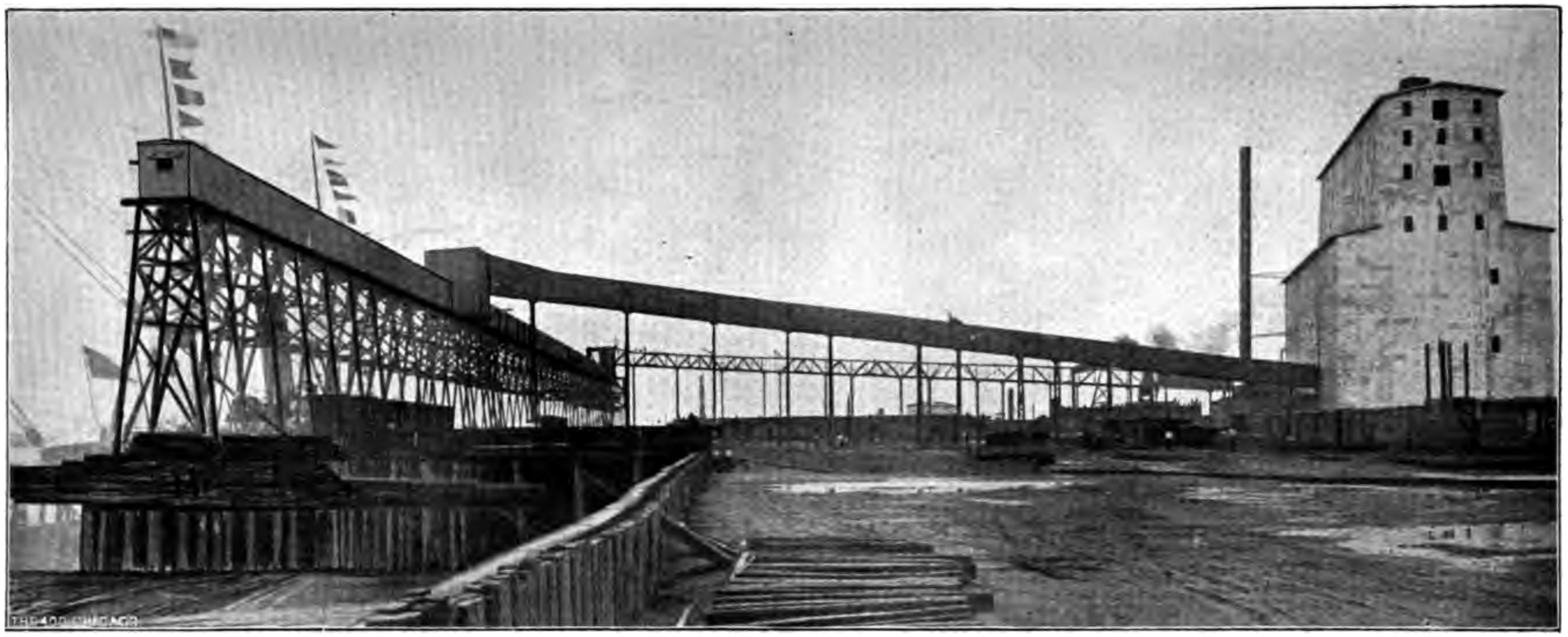
16 John H. O'Connor
17 J. W. Castle
18 Abraham Lehman
19 G. W. Young
20 Albert Baldwin

SOME OF THE MOVERS IN THE FIELD

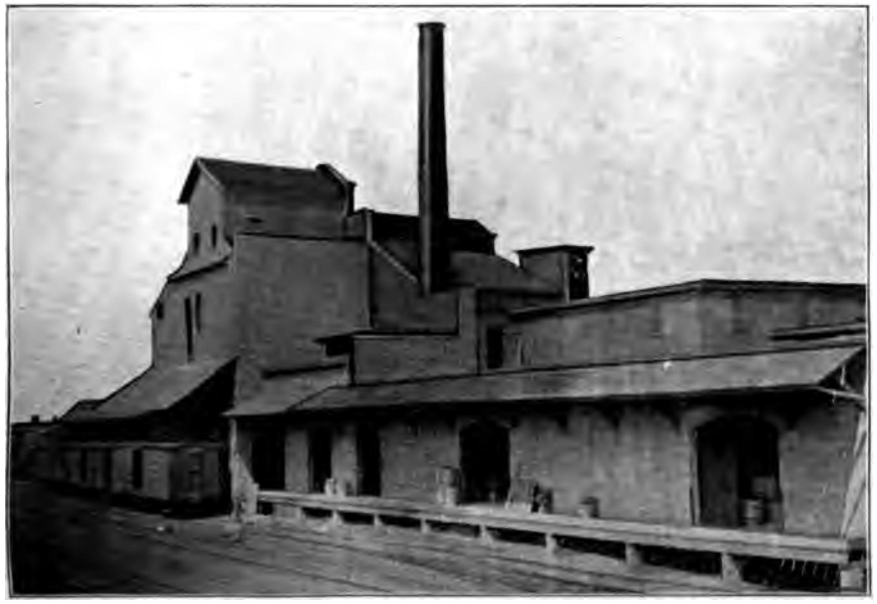


1 I. L. Lyons
2 Frank A. Daniels
3 A. A. Maginnis
4 Branch M. King
5 J. H. Keller
6 J. H. Stauffer
7 Wm. A. Kernaghan
8 The Late A. H. May
9 The Late Simon Hernsheim
10 The Late Charles Chaffe
11 P. J. Henderson
12 Sidney Story
13 Hugh McCloskey
14 Augustus May
15 R. E. Craig
16 Bishop Sessums

VOR IN NEW ORLEANS, PAST AND PRESENT



STUYVESANT DOCKS



FISHER SAWMILLS

ELEVATOR OF B. F. GLOVER & SON

strike here is extremely rare, and, when it does occur, a peaceful and satisfactory solution is soon effected. There is an abundance of cheap labor here—the negro element. Living among the poorer class of the people is very cheap, compared to what it is in the cold northern countries. The dwellings are not expensive, and there is no need for the heavy clothing that is required eight months in the year in more northern climes. The thermometer rarely reaches the freezing point, and when it does it does not stay there more than a few days. There are many children of the poorer classes who go barefooted the whole year round. Necessities of life are abundant and cheap. Taken all together, the lot of the poorer classes is better here than elsewhere, and therefore they can afford to work for less wages.

Now, as to the question of water and a fuel supply, New Orleans is as well located as any of the big manufacturing centers of the north. Lying on the banks of the Mississippi, with its inexhaustible supply of water to be had by simply running a pipe to the river, or, when the new water-works system is inaugurated under municipal control, at a minimum cost, that question is easily solved. As to fuel, the coal fields of West Virginia are placed practically at our doors by that same great river, while the developing coal fields of Alabama are ready to pour in any quantity by rail. If bought in large quantities, it can be had at very low rates.

When you consider the question of the raw product, then you begin to wonder why for all these years New Orleans has been paying tribute to distant manufacturers, when much of the raw material which she bought in manufactured form came from this vicinity.

One of the first instances that attract notice is cotton. The fleecy staple is shipped all the way to the mills in the eastern states, manufactured into cotton goods, and then shipped back here to be sold to the producers, who pay sufficient profit to enrich the eastern manufacturers and support that entire section. This particular branch of industry has been exhaustively discussed in this city, with the result that several projects for the organization of cotton mills here have been set on foot, and some of them have been successfully launched. The southern country has taken up the cry of bringing the factories to the cotton fields, and dispatches tell of the organization of cotton mill companies in several near-by towns. But not only should they be built there, but New Orleans should resound with the buzz of a million spindles, weaving not only the cloth to be worn by our own people, but a wealth for those people. In the cotton spindle there is a world of wealth, as has been demonstrated by the eastern spinners. If they can make a success of it, so far from the source of supply, and under difficulties of climate and labor which do not exist here, how much more of a success can we make of it here? That it can be made a success, look at the successful mills in Georgia and North and South Carolina. There is no need to go that far. Look at the two big cotton mills right here in the city, which have been so successfully operated, and whose looms are never idle.

Cotton, however, is not the only raw product that ought to be manufactured here in large quantities. New Orleans ought to be the center of the wood-working industries of the country. Louisiana's forests teem with pines and oaks and ash, and there are millions of acres of cypress swamps. These woods are all suitable for manufacture into various commercial commodities, and particularly furniture. That furniture factories can be successfully run here, there are two examples to point to which show what can be done when energy and enterprise, backed by a little capital, set to work on the proper line. At one time there were several furniture factories started here within a short period. Some of them failed, not because of the fact that such a business could not prosper here, but because they had not sufficient capital, or were improperly managed. Box factories have flourished here to a limited extent. Small wagon and buggy factories have been successful, but they lacked the capital to expand and grasp a trade that was within their reach, but which they saw taken away by the big concerns of the north, which have made most of their wealth by sending their farm wagons and buggies and other vehicles down here for sale. Woodenware factories ought to be successful, and one has been started in a neighboring town, which has done fairly well. As for the manufacture of fine furniture from the costlier hard woods, there could not be a better site for a factory than in New Orleans. These woods come from the tropical countries, and our nearness to Central America and Mexico ought to make New Orleans the ideal place. In fact, thousands of these logs come here and are shipped to the north.

The New Orleans Picayune, one of the great

HOWARD MEMORIAL LIBRARY

THE NEW ST. CHARLES HOTEL

dailies of this city, has issued a neat pamphlet entitled "Cotton Mills and Manufactories," containing a series of very interesting and highly instructive letters, written by their two able and gifted staff correspondents, Messrs. H. H. Hargrove and Will M. Steele.

These letters have attracted widespread attention throughout the northern and southern states for the very able presentation of the movement looking for the building of cotton mills and other manufactories in New Orleans. Any one interested can have a copy mailed to his address by applying to the offices of the Daily Picayune or the New Orleans Progressive Union.

The nearness of New Orleans to the fast-developing iron region of Alabama ought to result in the development of iron and steel industries in this city. The great Carnegie plants in and around Pittsburg get all their ore from the mines on Lake Superior, but they have built a city, or, rather, a score of cities, at the confluence of the Allegheny and Monongahela Rivers that has more tonnage than any city in the country. Even Cincinnati, an inland city, far removed from the iron and coal regions, has a large number of immense manufacturing concerns which turn out iron and steel products. In fact, a great deal of the heavy foundry work for Louisiana sugar machinery is done in that city. It could as well and as easily be done right here.

New Orleans presents superior advantages as a site for a rubber goods factory, owing to the development of the rubber tree plantations in Central America. Some rubber is already coming through here for shipment to northern concerns. It could as well stop here and be manufactured and then sent abroad.

There is a cork factory in Pittsburg which covers acres of ground, which, of course, imports all of its raw material from Spain and Portugal. The cork forests of Central and South America are nearer to New Orleans, and there is no railroad freight to pay, and such a concern could as well flourish here. Yet the various bottling establishments here get their corks evidently from one of these interior factories.

Ships coming to this port from India, for cotton for Liverpool, bring over thousands of bales of hemp, which is shipped to the bagging and twine and rope factories of the interior, only to come back here in the shape of the marketable article, for which we pay, besides the profit to the manufacturer, the freight to and fro.

New Orleans has shown that she could manufacture shoes in large quantities, and profitable, for one concern here has shipped large quantities to the Baltic.

There are dozens of other features which could be pointed out, but these are only thrown out as suggestions. An investigation of any one of them will show that these statements are based on fact.

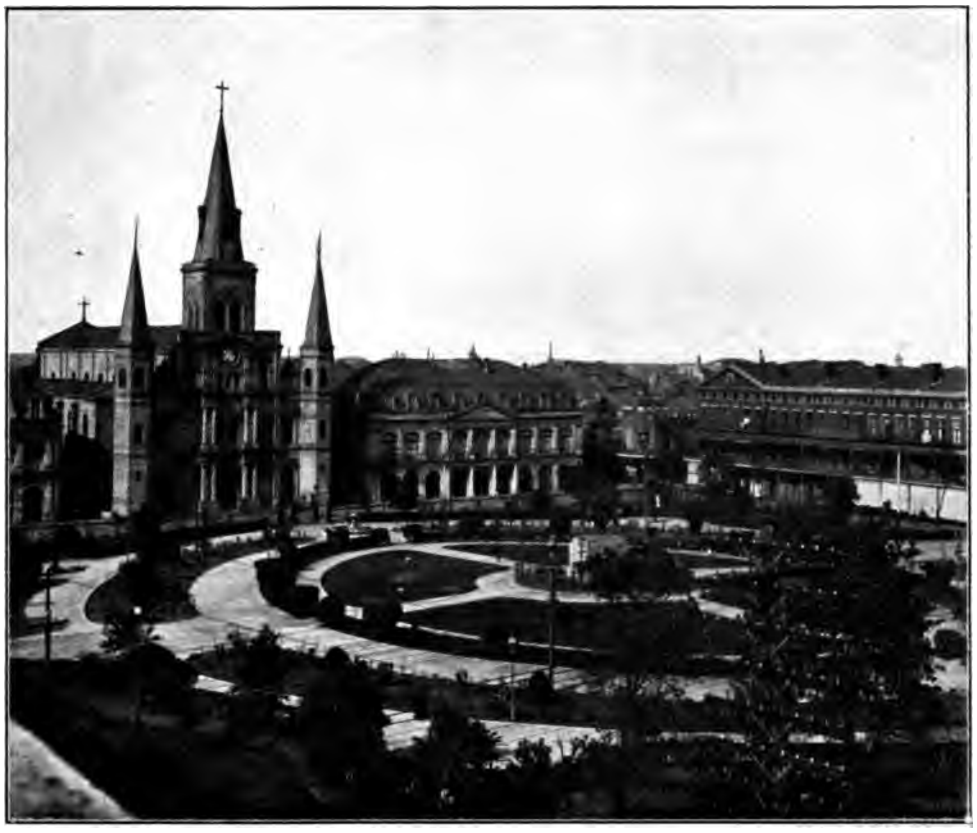
Another and a very important consideration to capital investing in manufacturing enterprises here is the encouragement offered by the state. The following article for the Constitution of the State of Louisiana, recently adopted, shows that exemption from taxation is offered for a period of ten years, which in itself is no mean inducement:

"There shall also be exempt from parochial and municipal taxation, for a period of ten years, from the 1st day of January, 1900, the capital, machinery and other property employed in mining operations, and in the manufacture of textile fabrics, yarns, rope, cordage, leather, shoes, harness, saddlery, hats, clothing, flour, machinery, articles of tin, copper and sheet iron, agricultural implements and furniture, and other articles of wood, marble or stone; soap, stationery, ink and paper, boat building and fertilizers and chemicals; provided, that not less than five hands are employed in any one factory; provided, that nothing herein contained shall affect the exemptions declared in this constitution."

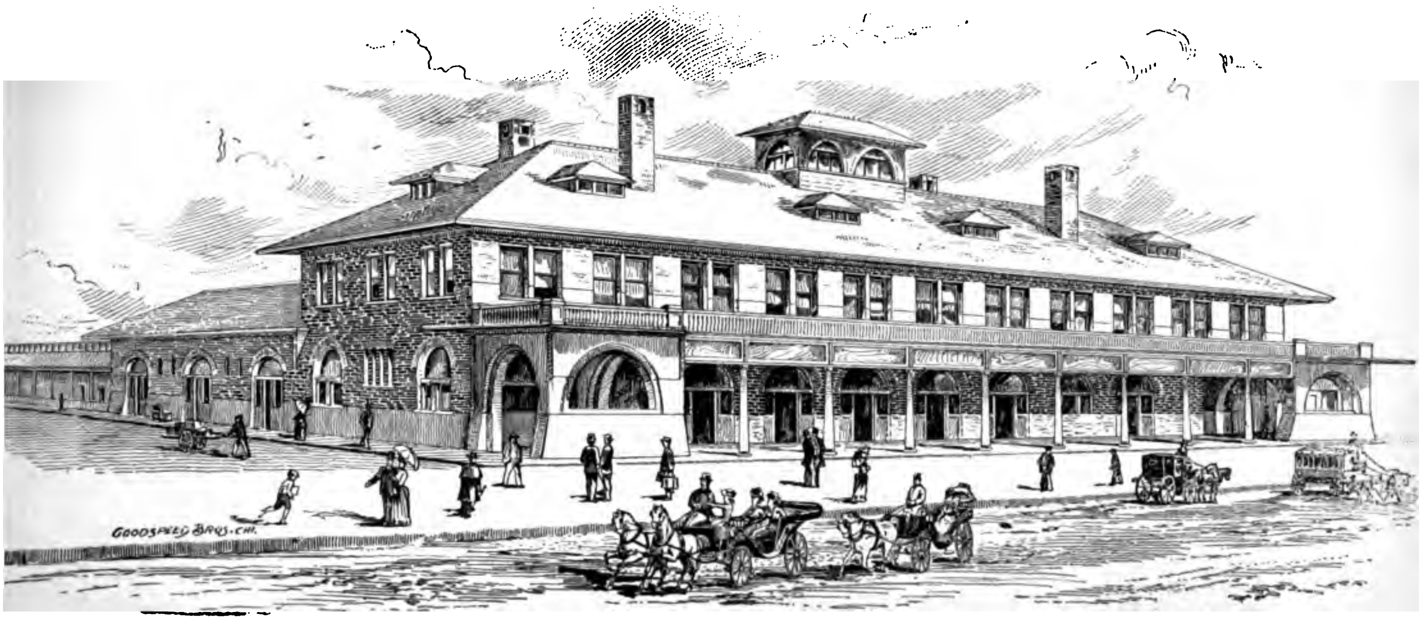
MARDI GRAS IN NEW ORLEANS

VIEWS IN THE PARKS OF NEW ORLEANS

NEW ORLEANS FURNITURE MANUFACTORY



VIEW OF JACKSON SQUARE AND THE CATHEDRAL


GOODSPEED BROS. CHI.

DEPOT OF THE ILLINOIS CENTRAL AND YAZOO-MISSISSIPPI VALLEY RAILROADS

GIBSON HALL—MAIN BUILDING, TULANE UNIVERSITY

LAW DEPARTMENT, TULANE UNIVERSITY

THE LATE WM. PRESTON JOHNSTON
First President Tulane University

DR. EDWIN A. ALDERMAN
President Tulane University

CHARLES E. FENNER
President Board of Administrators Tulane University

THE LATE DR. T. G. RICHARDSON

THE TULANE UNIVERSITY OF LOUISIANA

BOARD OF ADMINISTRATORS

Charles Erasmus Fenner, President James McConnell, 1st Vice President Robert Miller Walmsley, 2d Vice President Edgar Howard Farrar, Benjamin M. Palmer, D. D., LL.D., Walter Robinson Stauffer, Henry Ginder, Joseph C. Morris, George Quintard Whitney, John B. Levert, Ashton Phelps, Charles Janvier, Walker Brainerd Spencer, Beverley Warner, D. D., Walter D. Denegre; with the Governor of Louisiana, Mayor of New Orleans, and State Superintendent of Public Education, as ex-officio.

The Tulane University of Louisiana, located in New Orleans, rests upon an endowment by Paul Tulane, a retired merchant of New Orleans, who spent the last years of his life in Princeton, New Jersey. In May, 1882, he signified his intention to donate "all the real estate owned and possessed by him in the City of New Orleans, State of Louisiana, for the promotion and encouragement of intellectual, moral and industrial education among the white young persons in the City of New Orleans, State of Louisiana, and for the advancement of learning and letters, the arts and sciences therein."

By an Act of the Legislature of 1884, ratified by a Constitutional Amendment in 1888, the administrators selected by Mr. Tulane to carry out the purposes of his donation became the administrators in perpetuity of the Tulane University of Louisiana and to them was transferred possession of all the rights, powers and privileges, formerly vested in the administrators of the University of Louisiana, with the buildings and property belonging thereto.

By subsequent gifts Mr. Tulane increased the endowment to over a million dollars. His noble example was followed by liberal gifts from Mrs. Newcomb and Mrs. Richardson, to which additional reference is made under the heads of Newcomb College and Medical Department. On "Founders' Day," celebrated with great eclat each year, the names of Tulane, Newcomb and Richardson are greeted with reverence and grateful affection by the friends of the University.

In 1894 the Academical Departments were removed from the old buildings of the University of Louisiana to the extensive and admirably adapted grounds on St. Charles Avenue opposite Audubon Park. About eighteen acres have been set apart as a campus and upon this have been erected large and handsome buildings, known as Gibson Hall, the Physical Laboratory, the Chemical Laboratory, Mechanical and Electrical Laboratories, Drawing Rooms, Work Shops and Power House. There is also a small working Observatory with two telescopes and astronomical instruments. These new buildings present a handsome architectural appearance, are commodious and well supplied with the appliances of instruction. Few institutions of the country are more admirably equipped.

Gibson Hall, named after Hon. Randall Lee Gibson, first president of the Board of Administrators, is the largest of these buildings, with a frontage of 250 feet. It is built of Bedford stone and contains the offices of administration, assembly hall, with various class rooms, lecture rooms and other facilities for work of faculty and students. A large hall and three adjoining rooms are devoted to the library, which contains about 25,000 volumes.

The museum is located in the third story of Gibson Hall and its valuable collection is being constantly increased.

The Linton-Surget hall in the same building contains the paintings, statuary, bric-a-brac, and about 2,000 volumes of miscellaneous books, donated by Mme. Surget to the City of New Orleans and placed under the custody of Tulane University.

The University as at present organized comprises the University Department of Philosophy and Science, University Department for Teachers, College of Arts and Sciences, College of Technology, Art Department, H. Sophie Newcomb Memorial College for Young Women, Department of Law and Department of Medicine.

The faculty consists of seventy-eight professors and instructors, distributed as follows: University Department, 15; College of Arts and Sciences, 17; College of Technology, 17; Newcomb College, 23; Law Department, 6; Medical Department, 26.

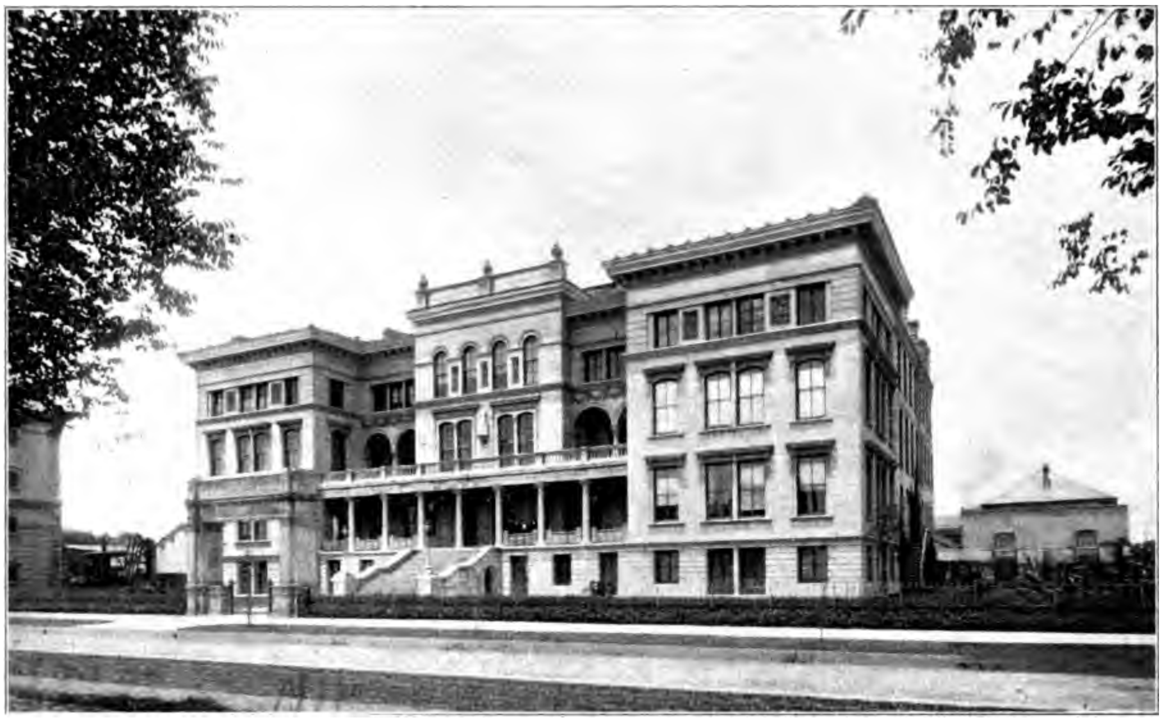
The attendance of students during the last session was, for all departments, 970, of whom 72 were in the Law Department, and 388 in the Medical Department. From present indications these numbers will be largely increased for the session of 1899-1900.

The departments of the college are well supplied with the best facilities. In the natural sciences laboratory work is required, and there are full courses of such work in physics, chemistry and biology. In these subjects large, special laboratories are provided, which will compare favorably with any in the country. In appropriate courses large use is also made of an excellent museum and of the special college library.

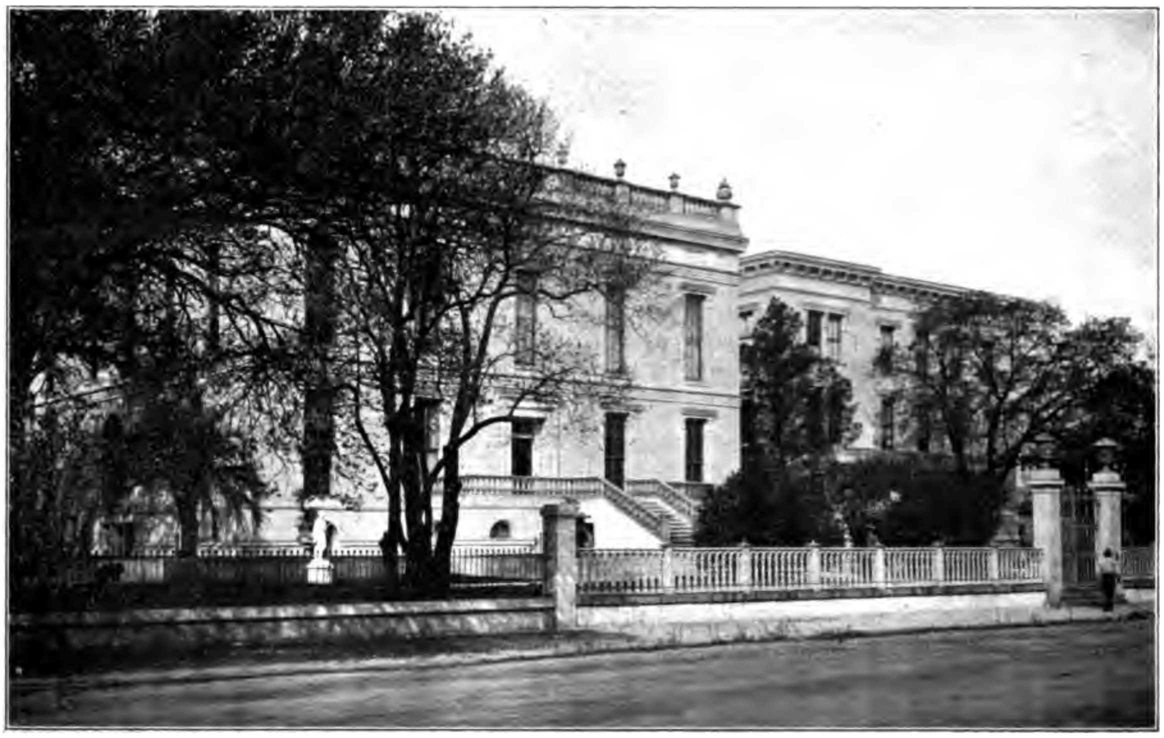
The College of Technology is devoted to the higher education of young men in engineering. It gives courses in mechanical, electrical, chemical, civil and architectural engineering and in the chemistry and engineering of sugar-making. The courses of study have been carefully planned with the object of fitting young men to take a prominent part in the development of the great natural resources of the South.

The equipment of apparatus, machines and models for the different engineering courses is already extensive and is being steadily increased. Laboratory work is a prominent feature in physics and chemistry. In civil engineering the collection of instruments, etc., is good. In drawing and architecture there are casts and examples of architectural details in plaster, terra cotta and metals. In electrical engineering the equipment is large and of an excellent character.

Full work is done in all the engineering courses. The course in sugar engineering is practical and leads to the special instruction of the student in the



RICHARDSON MEMORIAL—MEDICAL DEPARTMENT, TULANE UNIVERSITY



H. SOPHIE NEWCOMB MEMORIAL FOR GIRLS, TULANE UNIVERSITY details of design, proper erection and economical management of a sugar factory and its machinery. The student is trained also in the chemistry of clarification and chemical control of the various processes of sugar-making.

Students graduating from these engineering courses have found no difficulty in securing remunerative and responsible employment.

The H. Sophie Newcomb Memorial College for Women was founded in 1886, by Mrs. Josephine Louise Newcomb, as a memorial to her daughter, and is devoted to the higher education of women.

The college buildings occupy a large square, several acres in extent, situated on Washington, Chestnut, Camp and Sixth streets, in the residence portion of the city. The beauty of its situation and surroundings is unsurpassed. Its extensive grounds, shaded by numerous live oaks, palms and other trees and shrubbery, are most attractive, while the mildness of the climate permits open-air recreation throughout the entire winter.

The group of buildings comprises: 1, Newcomb Hall, which, in addition to various class rooms, contains the library and an assembly hall capable of seating 700 persons; 2, Academy, with a gymnasium upon the first floor, and upon the second and third floors the biological, physical and chemical laboratories, lecture rooms and recitation rooms; 3, the College Chapel; 4, Art Building, containing numerous studios and class rooms, picture galleries and an art library, where every facility is offered for the study and practice of industrial and fine art; 5, the Pottery, with kilns and other appliances for a course in Ceramic art; 6, Josephine Louise House for boarding students.

These buildings are of substantial character, attractive in architecture, and afford one of the most pleasing prospects in the city.

The College offers three regular courses of study: Classical, Modern Language, and Scientific, leading to the degree of Bachelor of Arts or Bachelor of Science. Graduates from either of these are admitted to university courses, at Tulane University, on the same conditions as are the young men who graduate from the College of Arts and Sciences, or the College of Technology.

In addition to the regular courses of study, Newcomb College offers normal courses in art and physical education, and special or elective courses in ancient and modern languages, mathematics, science, history and art.

The system of education is liberal and thorough, and the grade of work accomplished in its various departments is of the highest order. This college is an earnest attempt to secure for the South as efficient and as generous a system of education as can be found in any of the best institutions in the North.

The Law Department is now in the fifty-second year of its existence. Its faculty has always been chosen from among the most distinguished members of the legal profession. Its graduates fill honorable positions at the bar and on the bench in this and other States. While the Civil Law is taught as the basis of the whole legal superstructure and machinery of the State, and as the foundation of its civil code and jurisdiction, the course of instruction is sufficiently comprehensive to prepare the students for admission to the bar, not only in this State, but also in any of the common law States of the Union. Students have access to the new State Law Library.

Since its organization in 1834 the Medical Department has held the first place in the Southern States in the confidence of the medical profession. This eminence has been maintained to the present time by the ability and distinction of its faculty, its unsurpassed means of teaching and the large number and eminence of its matriculates and graduates.

The Medical Department now occupies the new building on Canal Street, erected and equipped through the munificence of Mrs. Ida A. Richardson as a memorial to her late husband, Dr. T. G. Richardson, for many years the dean of the Medical Department.

The new building, four stories in height, provides ample accommodation for large classes and for all the needs now requisite to medical education, with large and better lecture and recitation rooms and well equipped laboratories.

These admirable laboratories, chemical, pharmaceutical, microscopical and for practical anatomy and operative surgery, now added to the unrivalled practical advantages for clinical, anatomical and pathological studies given by the Charity Hospital, enable the Medical Department to provide its students with unsurpassed advantages for their medical education.

These educational advantages have been still further increased by recent improvements, notably by the addition of the Milliken Memorial, a superb modern and model building for the accommodation of two hundred sick children.

It is obvious that no purely theoretical instruction can compensate for the lack of practical knowledge gained at the bedside and in presence of sick and suffering. This practical knowledge is acquired in the Charity Hospital. The use of the wards of this noble institution, with its 900 beds and 10,000 annual patients, and the use of the two clinical buildings with more than 20,000 annual out-door patients, have been given by Acts of the Legislature to the professors of the Medical Department of the Tulane University of Louisiana for the practical instruction of its students not only in medicine and surgery, but also in obstetrics and gynecology. Medical students are given access to the hospital for purpose of practical instruction.

The superior advantages offered by the Medical Department serves to attract students from all parts of the country. The attendance this year is greater than ever before.

Col. Wm. Preston Johnston was selected by the Board of Administrators in 1883 to organize the University under the terms of Mr. Tulane's donation. He continued to guide its development with admirable tact and wisdom until his death, which occurred in July, 1899.

On the 5th of April, 1900, Dr. Edwin Anderson Alderman was elected president of Tulane University by the Board of Administrators of the Tulane Educational Fund.

President Alderman is a young man, only thirty-eight years of age. He is a Southerner born and bred. He is a Christian gentleman. He is a man of splendid presence, and of refined, polished manners. His scholarship is brilliant and varied, not narrowed to any particular specialty, but evidencing a broad and general culture. His entire life has been devoted to education, and his career as the president of the University of North Carolina has given him a large experience in university administration and development.

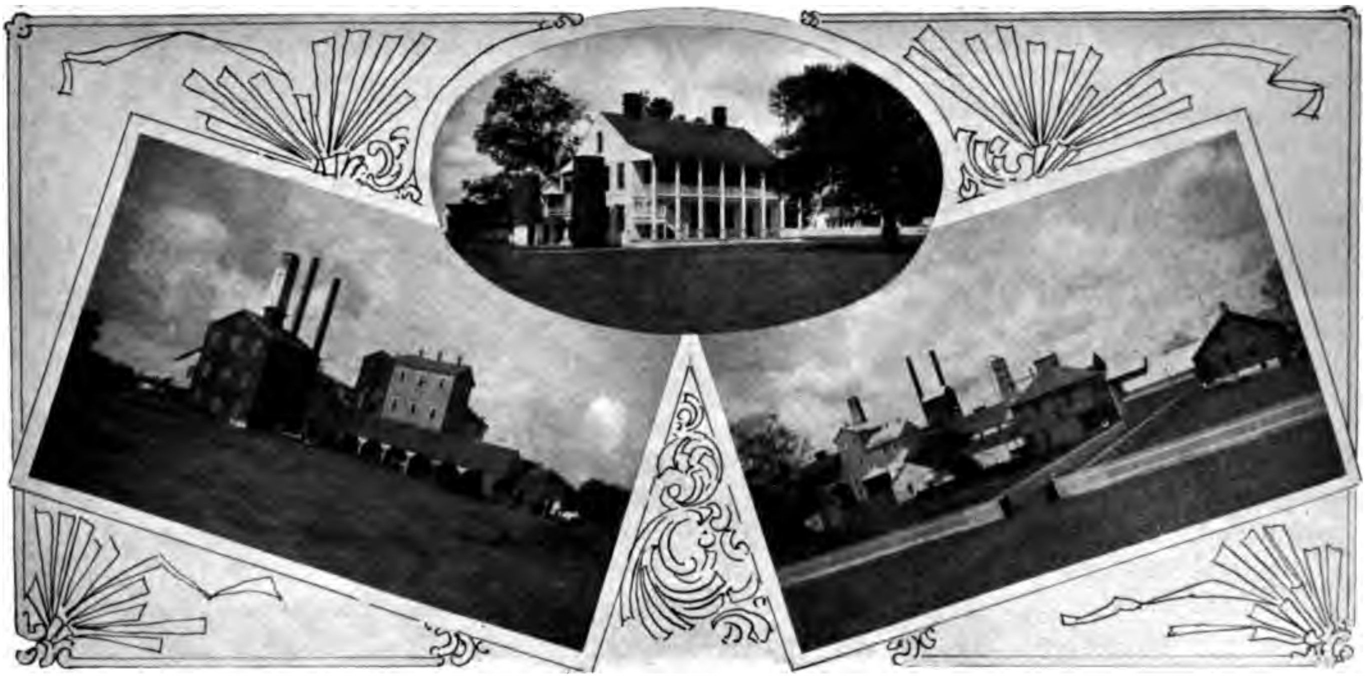
Tulane University is, in tone, Christian, but not sectarian. The discipline is mild, but firm. The regularly matriculated students of the colleges constitute the Academic Corps and elect a Board of Directors, to which, for the past thirteen years, has been entrusted the general discipline and good order of the Academic Corps. The system has worked satisfactorily.

An Advisory Board, composed of representatives from the faculty, students and alumni, have the general direction of college athletics.

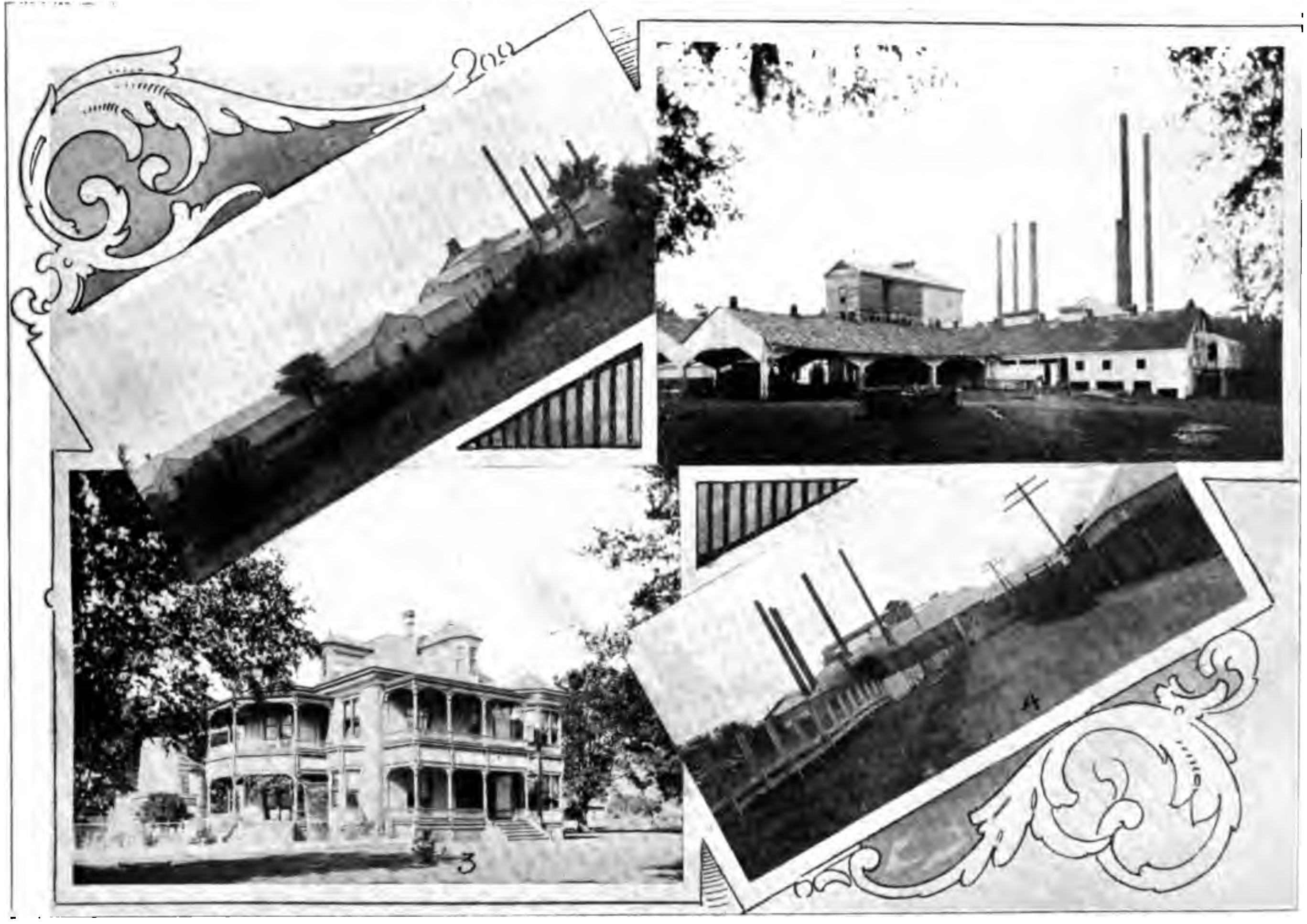
Expenses are moderate and about two hundred scholarships are annually given in the Academic Departments.

The admirable location of Tulane University in the great metropolis of the Southwest; the wealth of its endowment; the ability and zeal of its administration and faculties; the extent and value of its equipment in laboratories and other appliances for the instruction of its students in the arts and sciences, and in preparation for technical and professional pursuits; its growing reputation for thorough intellectual and practical results, all combine to place the institution upon a strong and permanent foundation and give reasonable assurance of a brilliant future of usefulness.

ART DEPARTMENT, H. SOPHIE NEWCOMB MEMORIAL, TULANE UNIVERSITY



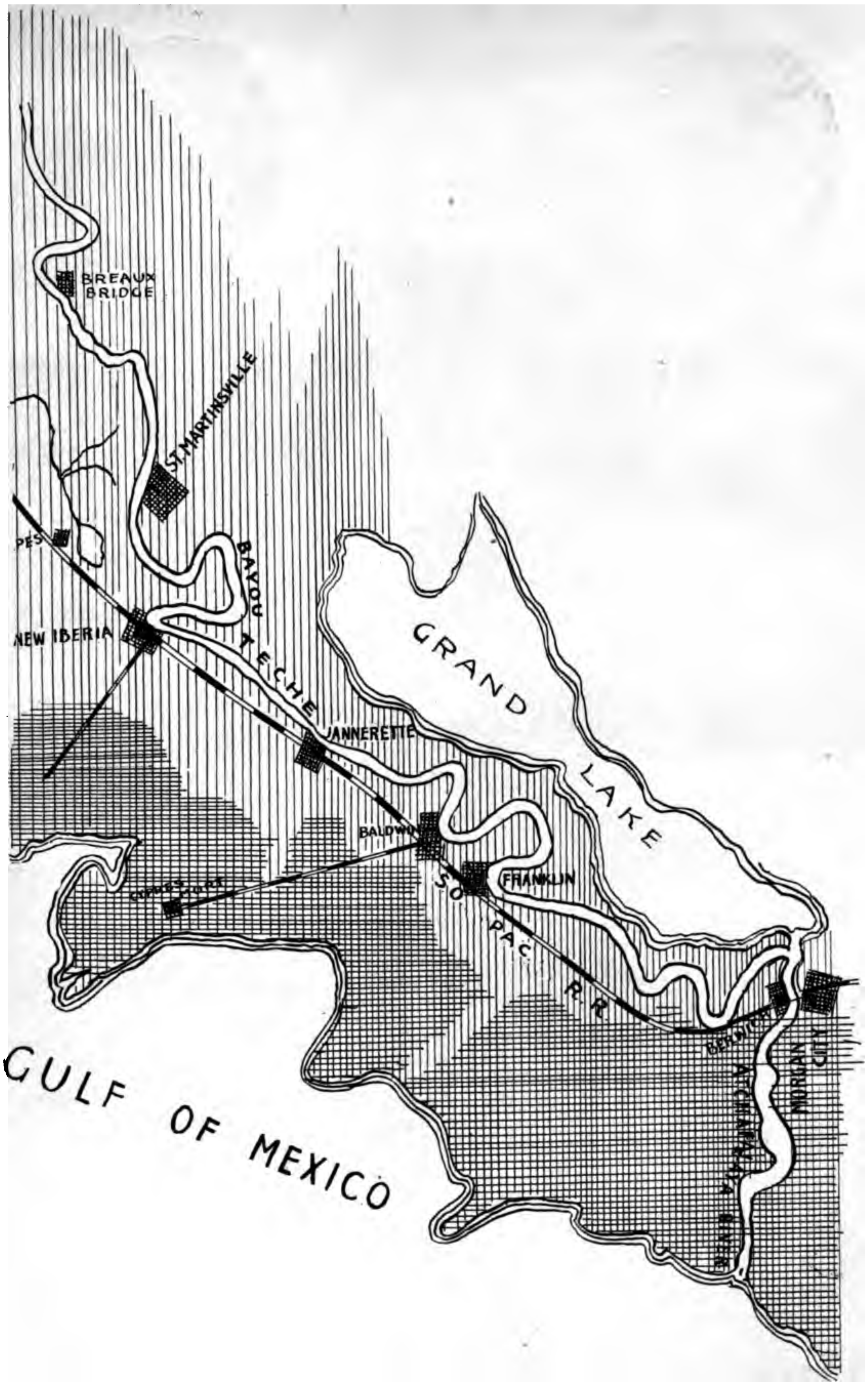
HOME AND SUGAR REFINERY OF EX-GOVERNOR WARMOTH, PLAQUEMINE PARISH



1 Loisel Refinery, Jeanerette
3 Residence Jno. N. Pharr, Berwick

2 Orange Grove Refinery, Olivier
4 Glenwild Refinery, Berwick

VIEW OF SUGAR PLANTATIONS OF JOHN N. PHARR AND PHARR & BUSSEY



BAYOU TECHE

"Just where the woodlands meet the flowery surf of the prairies."—*Evangeline.*

MAYOR LEWIS
Franklin, La.

MAYOR C. KLINE
Donaldsonville, La.

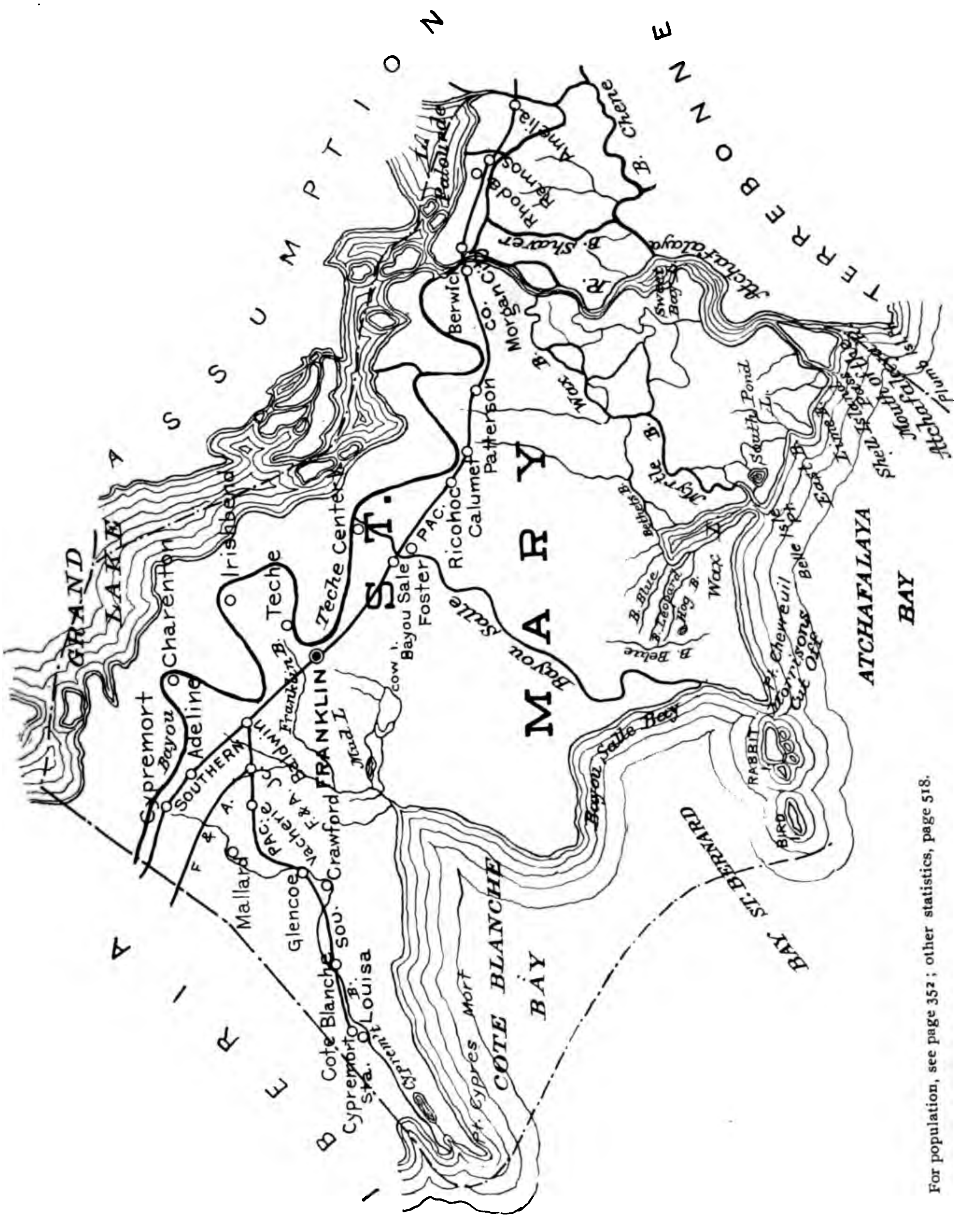
BAYOU TECHE

Beautiful is the land, with its prairies and forests of fruit trees;
Under the feet a garden of flowers, and bluest of Heavens
Bending above, and resting its dome on the walls of the forest.
They who dwell there have named it the Eden of Louisiana.
—*Evangeline.*

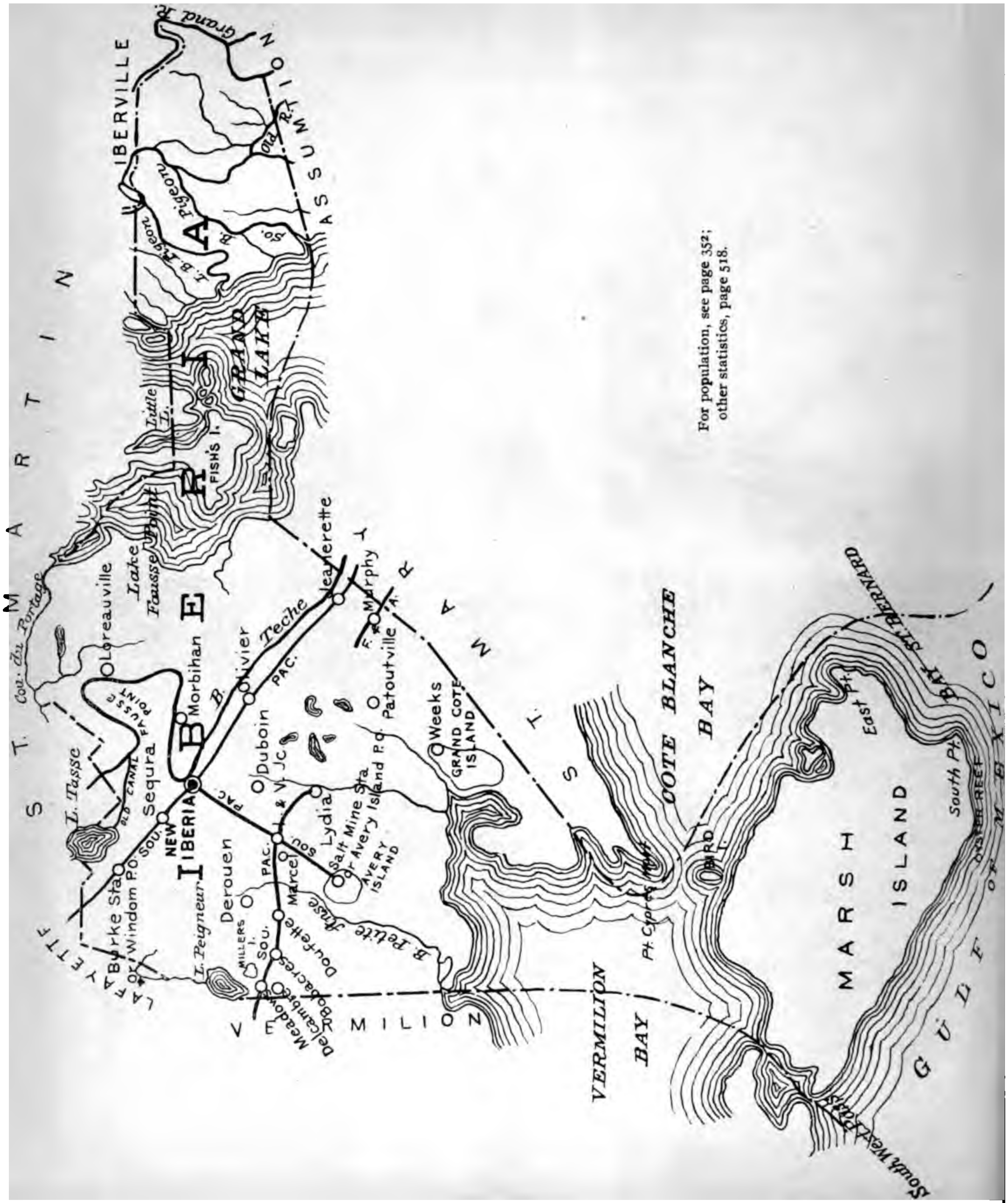
That portion of Louisiana through which the beautiful Teche finds its way—the southern central portion of the State—is famous, not alone because its attractions have been sung in song by the poet, but because it has had its beauty and its countless attractions spread far and wide by those who have seen this "Eden of Louisiana."

Not only is it beautiful, but it is fertile as well, and in its fertile area is located some of the finest sugar plantations, some of the greatest hardwood lumber mills, and some of the most prosperous little cities of the State. In the parishes which border the Teche the sugar cane is the exclusive large crop, save in St. Landry, St. Martin and Iberia cotton is grown to a more or less extent. The growth of this section of the State, both in wealth and population, is shown by the statistics which are to be found on pages 352 and 518.

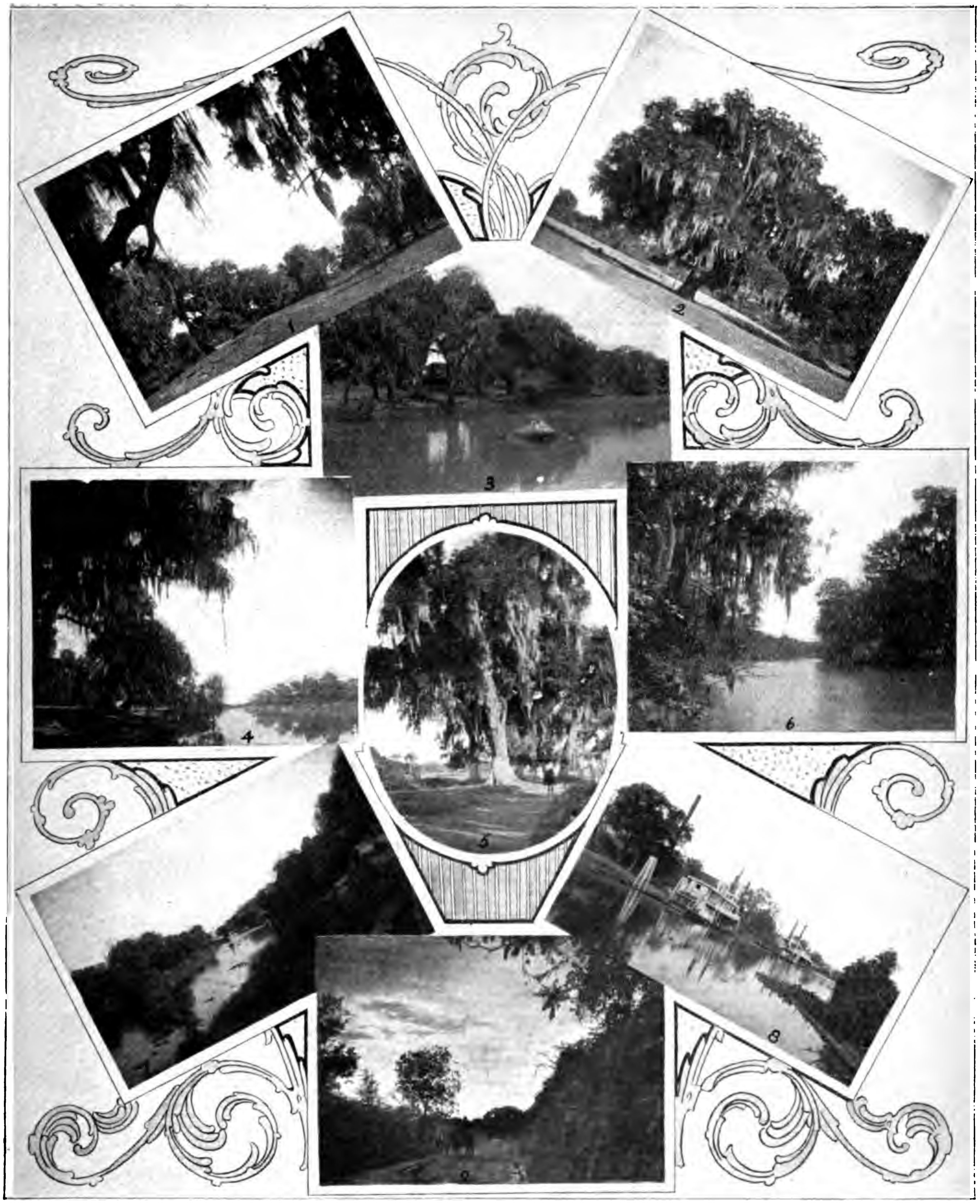
The principal cities and towns are Breaux Bridge, New Iberia, Franklin, Patterson, Jeannerette, Morgan City and St. Martinsville. They are all quite attractive in appearance and are prosperous and growing places. The bayou region of the Teche and Lafourche also includes Bayou Plaquemine, Bayou Terrebonne, Bayou de Large, Bayou Petite and others along the banks of which are scenes of rare beauty to charm the eye. On the fertile high-lands of all these bayous are located fine sugar plantations. The views of this region given in this book speak their own praises and utter their own discriptions.



For population, see page 352; other statistics, page 518.

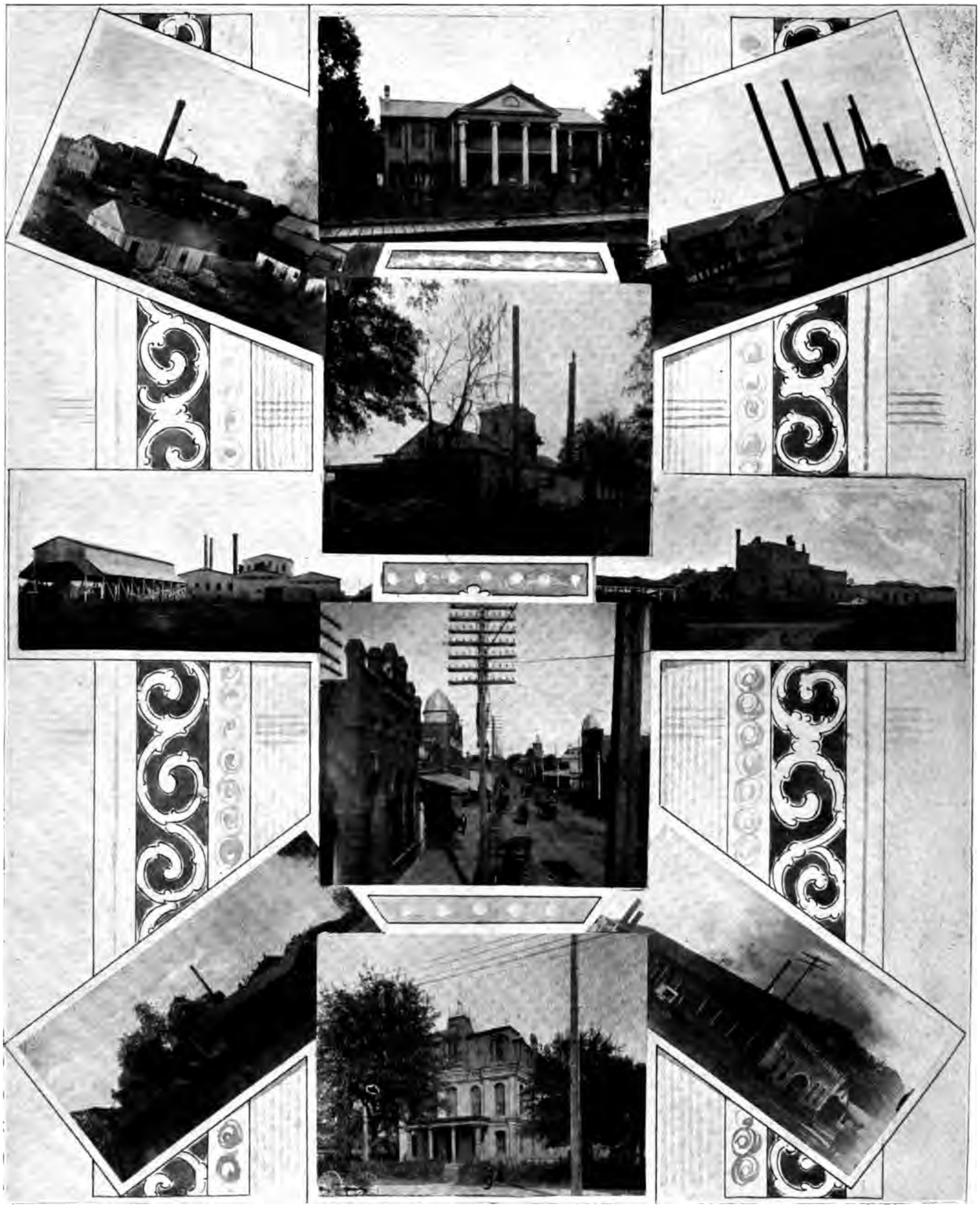


For population, see page 352; other statistics, page 518.



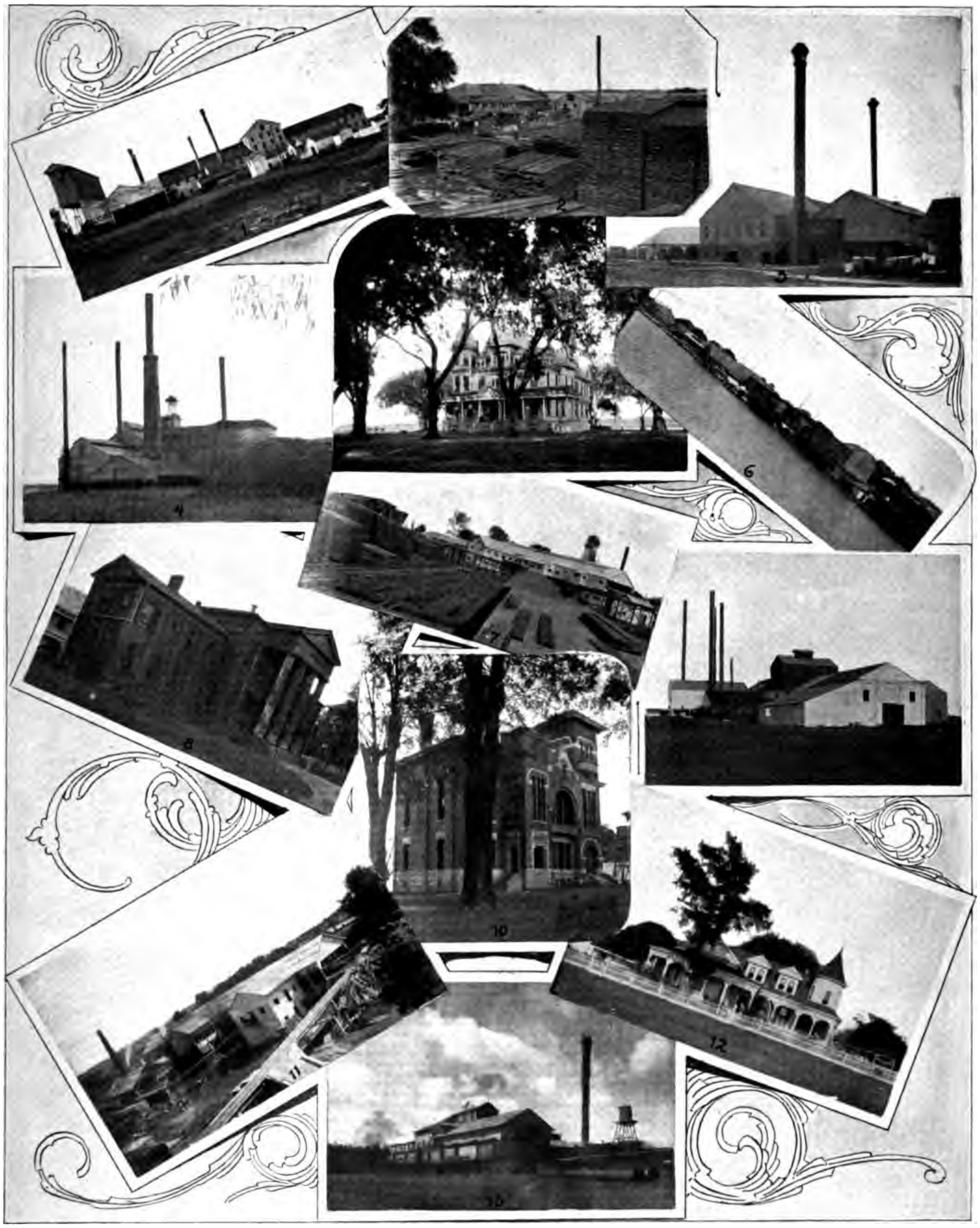
"Garlands of Spanish moss and of mystic mistletoe flaunted,
Such as the Druid's cut down with golden hatchets at Yule-tide."
—*Evangeline.*

SCENES ALONG THE BEAUTIFUL TECHE



1 Vanfrey Sugar Refinery, Jeanerette
2 Residence of O. L. Mounot
3 Sugar Factory O. L. Mounot Jeanerette
4 Sugar Factory of Shelby H. Saunders
5 Segura Sugar Manufacturing Co., New Iberia
6 Adeline Refinery, Adeline, La.
7 Main street, New Iberia
8 An important New Iberia industry
9 Court House. New Iberia
10 Morris Foundry, New Iberia

VIEWS ALONG THE BEAUTIFUL TECHE



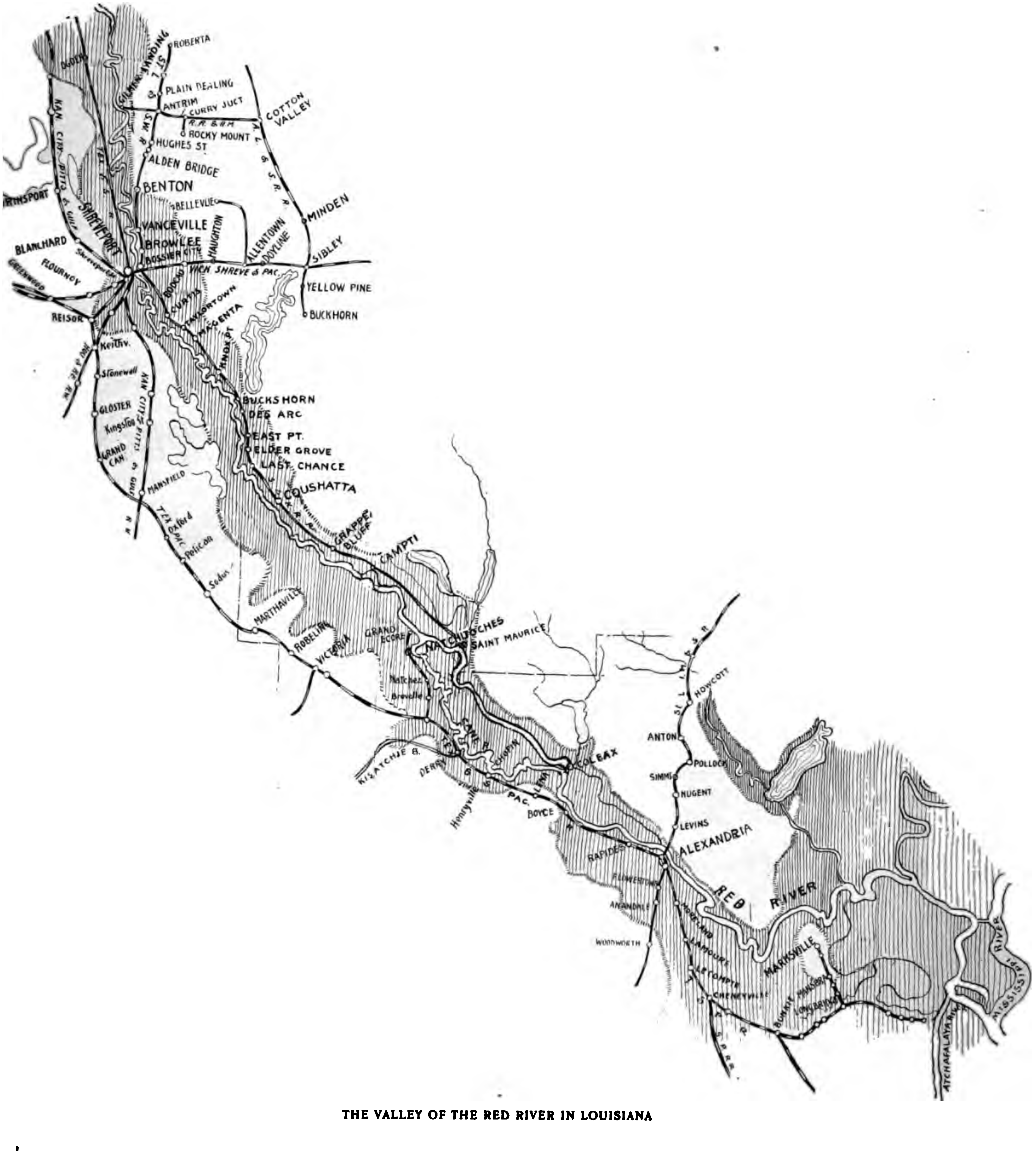
1 **Shadyside Refinery**, of J. W. Barnett, Calumet, La. 2 Hardwood Lumber Mill. 3. Calumet Refinery, Calumet, La. 4. Logonda Refinery, Patterson, La. 5. Residence of J. W. Barnett, Calumet, La. 6. Oyster Industry, Morgan City, La. 7. F. B. Williams, Sawmill, Patterson, La. 8. Court House, Franklin, La. 9. Belleview Refinery, Franklin, La. 10. County Jail, Franklin, La. 11. Lumber Plant, Franklin, La. 12. Residence on Belleview Plantation, Franklin, La. 13. Franklin Sugar Refinery, Franklin, La.

VIEWS ALONG THE BEAUTIFUL TECHE.

NEW IBERIA HIGH SCHOOL, NEW IBERIA, LA.

CYPRESS TANK AND MANUFACTURING CO., PATTERSON, LA.

A SUGAR PLANTER'S RESIDENCE—JOHN D. SHAFFER, TERRE BONNE, PARISH



THE VALLEY OF THE RED RIVER IN LOUISIANA

RED RIVER VALLEY

Of all the valleys which form a part of the great Mississippi River alluvial lands, that of Red River is the largest. In the State of Louisiana alone the alluvial lands of this river are estimated to be over 1,700 square miles, occupying, as it does, large portions of the Parishes of Caddo, Bossier, Red River, Natchitoches, Rapides, Avoyelles, St. Landry and a small part of two or three others. This valley has long been noted for its fertility and the generally prosperous condition of its people.

In the general description of the alluvial lands of Louisiana special mention is made of the growth in population of some of these parishes, and by reference to the table of assessed valuation in the same connection it will be seen that their financial improvement has fully kept pace with the increase of population.

Shreveport, its chief city, is one of great commercial and industrial activity at present, and bids fair to be one of the largest inland cities of the Southwest. Shreveport has a greater number of railroads for its population than any city in the world. Besides this it has an all-the-year-round navigation of Red River, both north and south. Thus it is admirably situated for a large wholesale or distributing point as well as for a center of industrial activity, and it is already both of these. While its growth during the last twenty years has been satisfactory (having almost doubled in population), its commercial, manufacturing and general shipping conditions have increased far beyond that ratio, and the population must, by the very nature of things, be more largely increased in the next two decades to keep pace with its facilities.

The railroads which enter Shreveport are the Vicksburg, Shreveport & Pacific; Texas & Pacific, with Southern and Western divisions; Houston, East & West Texas; St. Louis South Western; Kansas City Southern; Texarkana, Shreveport & Natchez; Shreveport & Red River Valley, and the Missouri, Kansas & Texas railroads.

The cotton receipts by rail for the season of 1898-99 were over 200,000 bales, thus making Shreveport the largest cotton market in the world in proportion to its population. In all fairness to Shreveport it must be said that the population given by the census does not represent, by many thousands, the full figures, as outlying districts and that portion of the city called East Shreveport which lies on the opposite side of the river in Bossier are not included in this enumeration. At East Shreveport is situated many of her most prosperous industrial enterprises, and must be considered as an important part of the city.

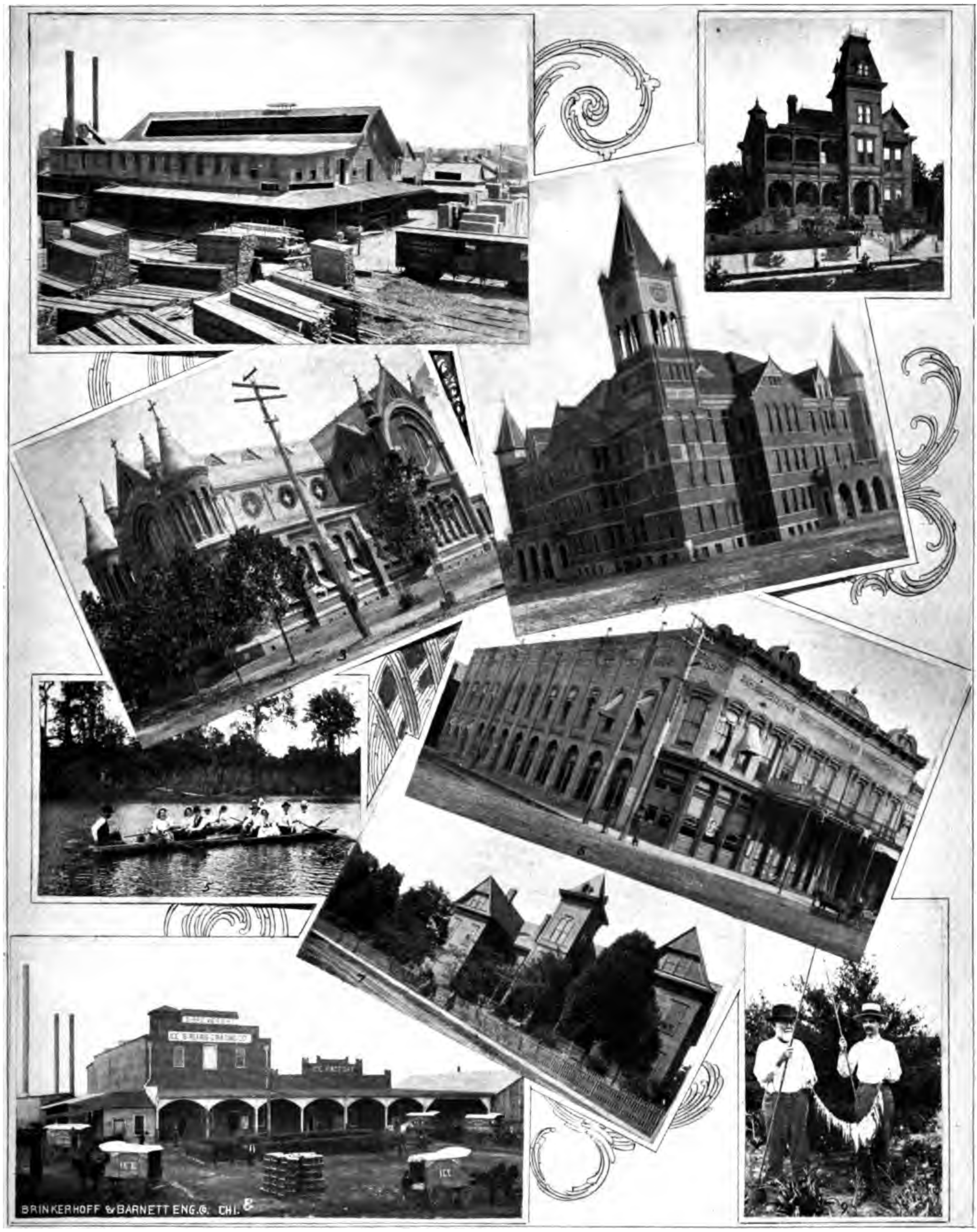
With its remarkable healthfulness, with its unexcelled facilities for distribution, and situated as it is in the center of a prosperous and growing section of the Southwest, Shreveport offers exceptional opportunities for successful manufactories of all kinds, and in addition to those industrial plants which she now has, and those in the course of erection, many more are projected or contemplated.

Mr. H. H. Hargrove, the well-known evangel of factories, especially cotton factories, in a recent article on Shreveport, writes as follows:

"We need a $10,000 to $15,000 furniture company; $10,000 woodenware, buckets, trays manufacturing plant; a $5,000 broom factory; a $10,000 rope and twine plant; a $20,000 hosiery mill; a $25,000 to $50,000 flour mill; a tannery, a shoe factory, a harness and saddle factory, a large tin-working plant, a chair and desk factory and, in fact, there are fifty small industries which by small stock-company subscriptions could be started in our midst without seriously affecting the cash of the people. We need a manual training school and a technical department of our public schools, to cost $25,000."

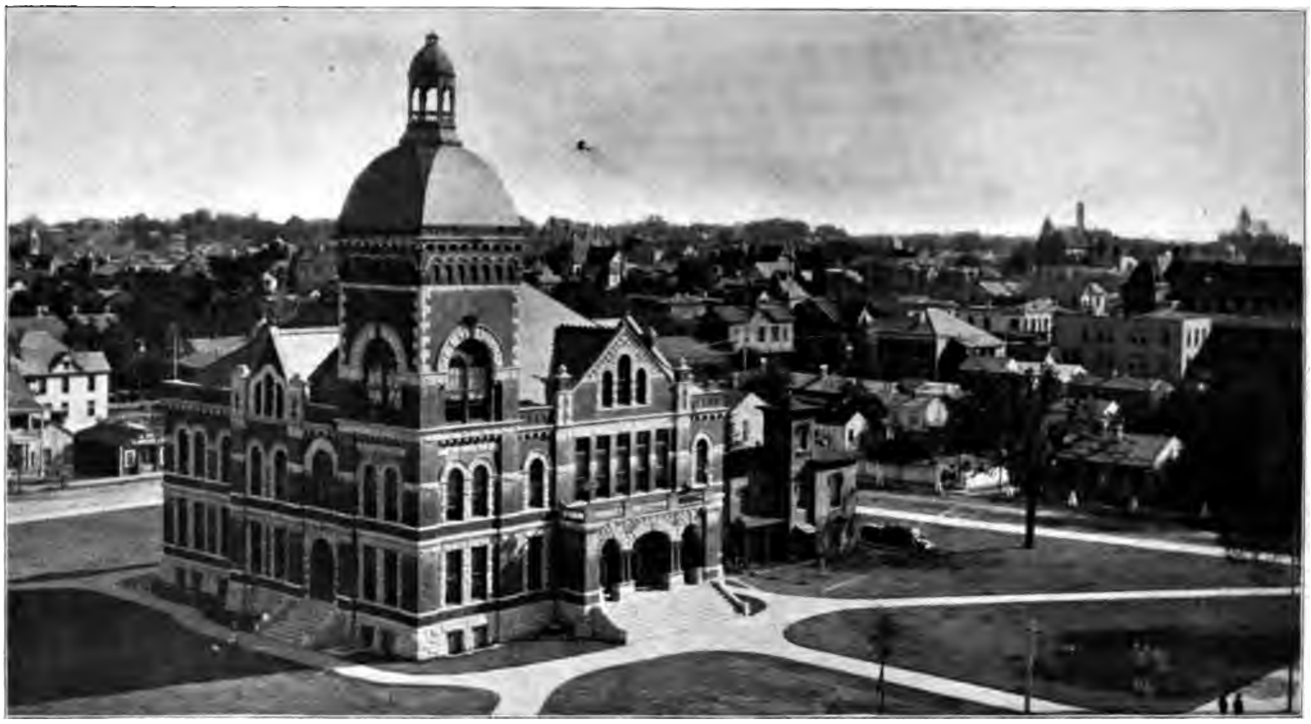
Without doubt all these enterprises could be successfully inaugurated here, and probably the next census will find not only these, but many similar industrial organizations in successful operation.

And Mr. Hargrove's allusion to the cash necessary to inaugurate these enterprises is very appropriate, in view of the fact that, financially, Shreveport is rather a remarkable city. With all these advantages mentioned and with the large accumulations of capital which are to be found here there is no reason to doubt the future of Shreveport. Shreveport is bound to be perhaps the largest inland city of the Southwest.



1 Victoria Lumber Company's Mills
2 Typical Residence
3 Catholic Church
4 High School
5 Coming Home from a Fish Fry
6 Merchants and Farmers Bank
7 St. Mary's Convent
8 Shreveport Ice and Refrigerating Co
9 A String of Beauties.

SHREVEPORT, LA.



FINE COURT HOUSE OF CADDO PARISH AND VIEW OF CITY

V., S. & P. BRIDGE ACROSS RED RIVER

VIEW OF SHREVEPORT FROM THE EAST SIDE OF RED RIVER

SHREVEPORT, LA.

Alexandria, the second city of the Red River Valley, is one of the growing places of Louisiana. Twenty years ago it was a small town. It has quadrupled its population since then and become an industrial and commercial point of importance. Its railroads are the Texas & Pacific, Southern Pacific, St. Louis, Iron Mountain & Southern, Kansas City, Watkins & Gulf. The Shreveport & Red River Railroad will soon be completed to this point.

Thus equipped with railroads, extending in all directions, and having in addition the Red River, it is an ideal location for a city. And additional roads are projected and contemplated which will eventually reach Alexandria. Predictions have been freely made that here will be one of the largest cities of Louisiana.

Natchitoches, quaint old Natchitoches, has always been one of the most interesting towns of the State. It has been noted for its fine school, fine churches and the intelligence and culture of its people. When it was first located (and it is one of the oldest places in Louisiana), Natchitoches was on Red River, but in the early years of the "late departed" century the river changed its main course, leaving the town on the smaller branch of a divided river. It is now called Cane River, and is navigable only in times of high water in the main stream.

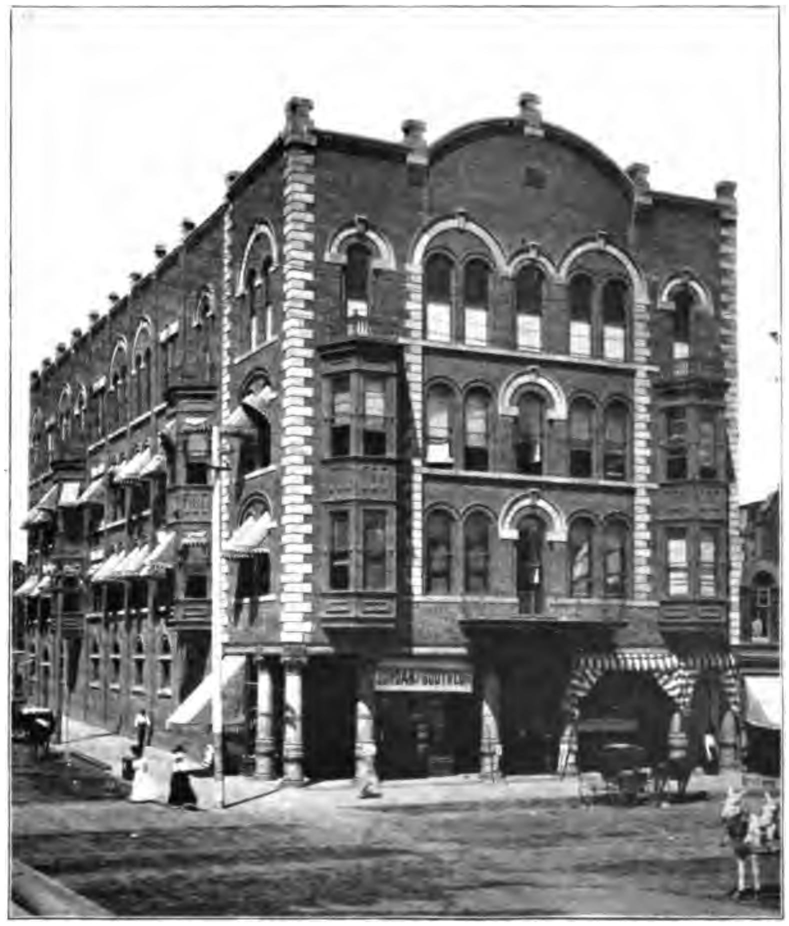
But Natchitoches has a railroad with termini at Grand E'Core, on Red River, and at Cypress on the Texas & Pacific Railroad. The people of Natchitoches are building a fine iron bridge across Red River at Grand E'Core, and this railroad will be built northward and will become valuable in extending the trade of Natchitoches, as it will traverse a country not only fertile, but heavily timbered.

Natchitoches is a progressive place and is growing both in wealth and population. Here is situated the Louisiana State Normal School, one of the most useful institutions of the State.

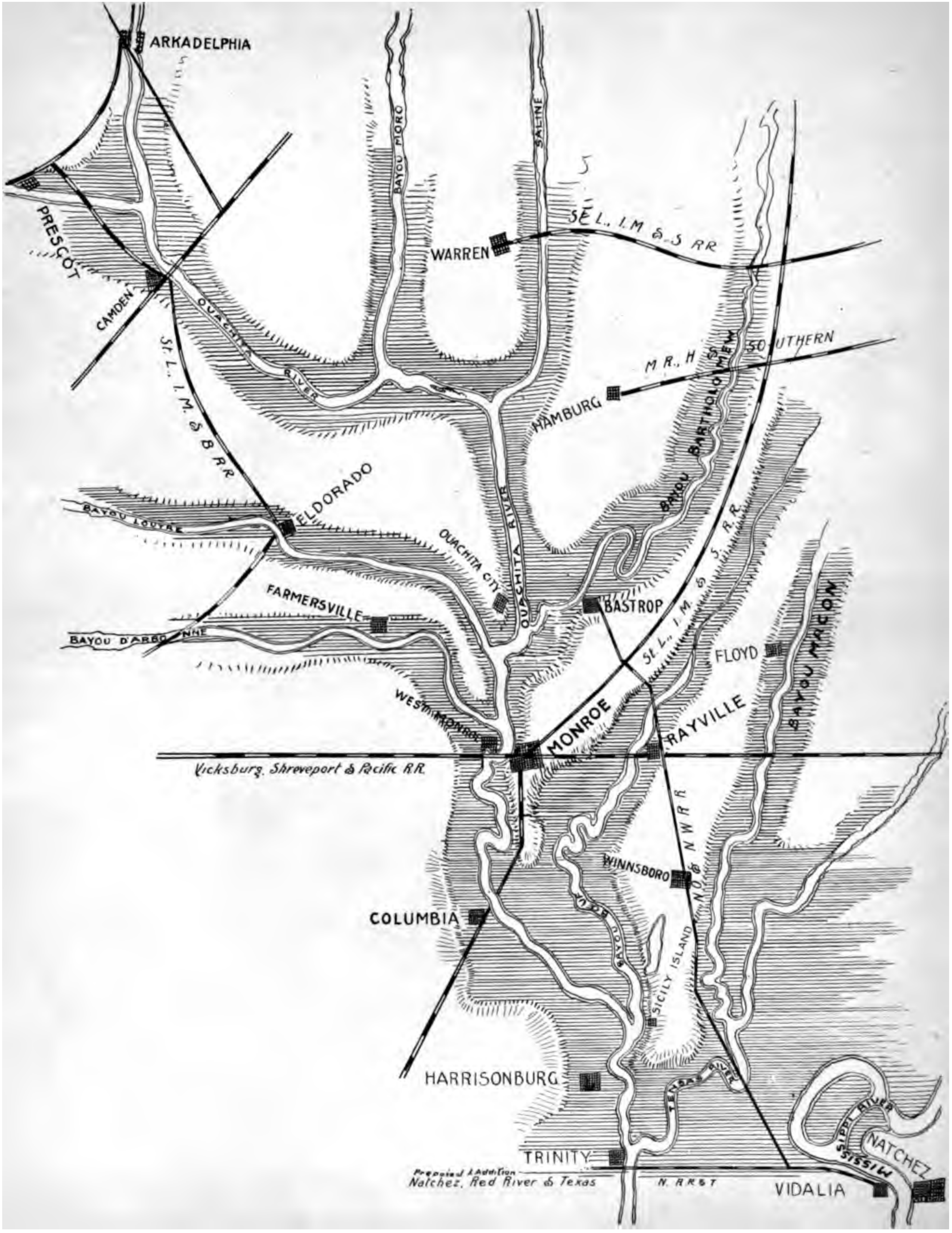
Founded in 1884, by Act of Legislature, its initial session opened in November, 1885. It has large and commodious accommodations, beautiful parkings and extensive grounds. It is an ideal place for a school. During the fifteen years of its existence it has been an important factor in the improvement of the morale of the schools of Louisiana. Under the direction, successively, of Prof. Edward E. Sheib, Col. Thos. D. Boyd, now president of the Louisiana State University, and Prof. B. C. Caldwell, it has prospered, developed and enlarged, and become indispensable to the educational unfolding of Louisiana.

The other towns of the Red River Valley are Pineville, Coushatta, Colfax, St. Maurice, Montgomery, Campti and others which are being located on the new Shreveport & Red River Valley road.

The Red River Valley is a fair and fertile part of Louisiana and is rapidly increasing in wealth and population.



A SAMPLE BUSINESS BUILDING OF SHREVEPORT, LA.



THE VALLEY OF THE OUACHITA RIVER—LOUISIANA AND PART OF ARKANSAS

OUACHITA VALLEY AND THE IMPROVEMENT OF THE OUACHITA RIVER

The United States Government has at different times made appropriations, in all amounting to nearly $300,000, for the purpose of preparing surveys, estimates, etc., of the Ouachita and Black Rivers to ascertain the practicability and feasibility of locks and dams to secure slack water navigation in times of low water.

Maj. J. H. Willard, United States Engineer Corps, has made several favorable reports on these projects. Since Maj. Willard's transfer to Chicago, this work has developed upon Maj. Thos. L. Casey. Gen. Wilson, Chief of Engineers, requested Maj. Casey to include in his report some statistics of commerce to be affected by the river improvement. A convention held at Monroe, La., November 9th, 1899, permanently organized the Ouachita and Black River Improvement Association, with Col. A. S. Morgan, of Camden, as president, representing Arkansas interests, and Hon. Uriah Millsaps, of Monroe, representing Louisiana interests, as vice president. This association, to assist Maj. Casey in securing these statistics, employed Mr. G. C. Strong, an expert statistician, to compile a comprehensive report on the resources of the Ouachita Valley.

This labor was performed in a very creditable manner, and the statement was not only correct and thorough in all its details, but was gratifying to the people of the Ouachita Valley and sustaining to the project by showing a probable benefit to very large interests.

These figures are not unreasonable, nor are they speculative. They simply represent exact facts and estimates of future benefits caused by these improvements are left to speculation.

The Ouachita Valley contains either wholly or in part, twenty-one counties and parishes in Arkansas and Louisiana, and the reports above mentioned develop the following facts regarding the area and commercial and manufacturing energy, capital invested, timber, etc.:

Total number of square miles (area), 15,738; total number of acres, 10,072,318; total population, 355,940; total assesses valuation, $36,427,617; total number of live stock, 494,776; actual value of same, $6,189,874; total acres in cultivation, 1,575,255; number of bales of cotton raised, 384,771. A compilation on the total tonnage on the Ouachita tributary streams for the season of 1898-99 discloses the following facts: Cotton (bales), 91,250; cotton seed (sacks), 154,167; eggs, (cases), 1,564; live stock (head), 2,283; lumber (feet), 271,500; staves (pieces), 976,362; provisions, 61,912; grain (sacks), 45,237; miscellaneous freight (packages), 224,577; cotton seed meal (sacks), 40,635; total weight in tons, 73,968; total estimated value, $5,608,360.

The miles of navigable streams included in this report is given as follows: Ouachita River (from mouth of Black River to Camden, Ark.), 400 miles; Little River, 150 miles; Tensas and Upper Tensas, 150 miles; Bayou Macon, 150 miles; Bayou Louis, 30 miles; Boeuf River, 200 miles; Bayou D'Arbonne, 80 miles; Bayou Bartholomew, 200 miles; Saline, 125 miles; Ouachita River (Camden to Arkadelphia), 80 miles; total miles, 1,565.

To show the dignity of the area represented by the Ouachita Valley the compiler compares it with the total area of the three States—Massachusetts, Rhode Island and Connecticut, which is 14,555 miles. These three States have a total population of 4,142,257 by the late census. The area of the counties and parishes mentioned as tributary to the Ouachita River is about nine per cent greater than the area of the above named States.

Many practical business men and manufacturers of timber were interviewed on this subject and gave some very valuable information. For instance, Mr. F. R. Pierce, vice president and general manager of the Louis Werner Sawmill Company, which have mills at Griffin, Kirkland, Lester, Sayre, Madison and Lansing, Arkansas, and Tioga, Louisiana, presents a statement in which he estimates that good navigation on the Ouachita River would open up a market for billions of feet of lumber which are on the Ouachita and tributary streams, inaccessible now because of its distance from rail transportation, and that with good transportation facilities on these rivers the value of this inaccessible timber would advance to an equality with the most favorably located timber along the different railway systems. There are large export firms dealing in lumber, staves and box material which are now shipping their productions through the Ouachita and Black Rivers, notwithstanding the shortness of the season.

During the time of low water many millions of feet of timber, staves and other manufactured forms of lumber lie on the banks of these rivers awaiting a rise which is often delayed until very late in the season. This naturally hampers operations. With navigation in these rivers all the year around this delay would be obviated. The loss of time, money and the natural danger and hazard of fire and other complications would be avoided. The development which would follow this improvement would be very rapid, and the growth of the country in population and wealth would keep pace with it.

CAMDEN COMPRESS, THE THIRD LARGEST SHED IN THE UNITED STATES

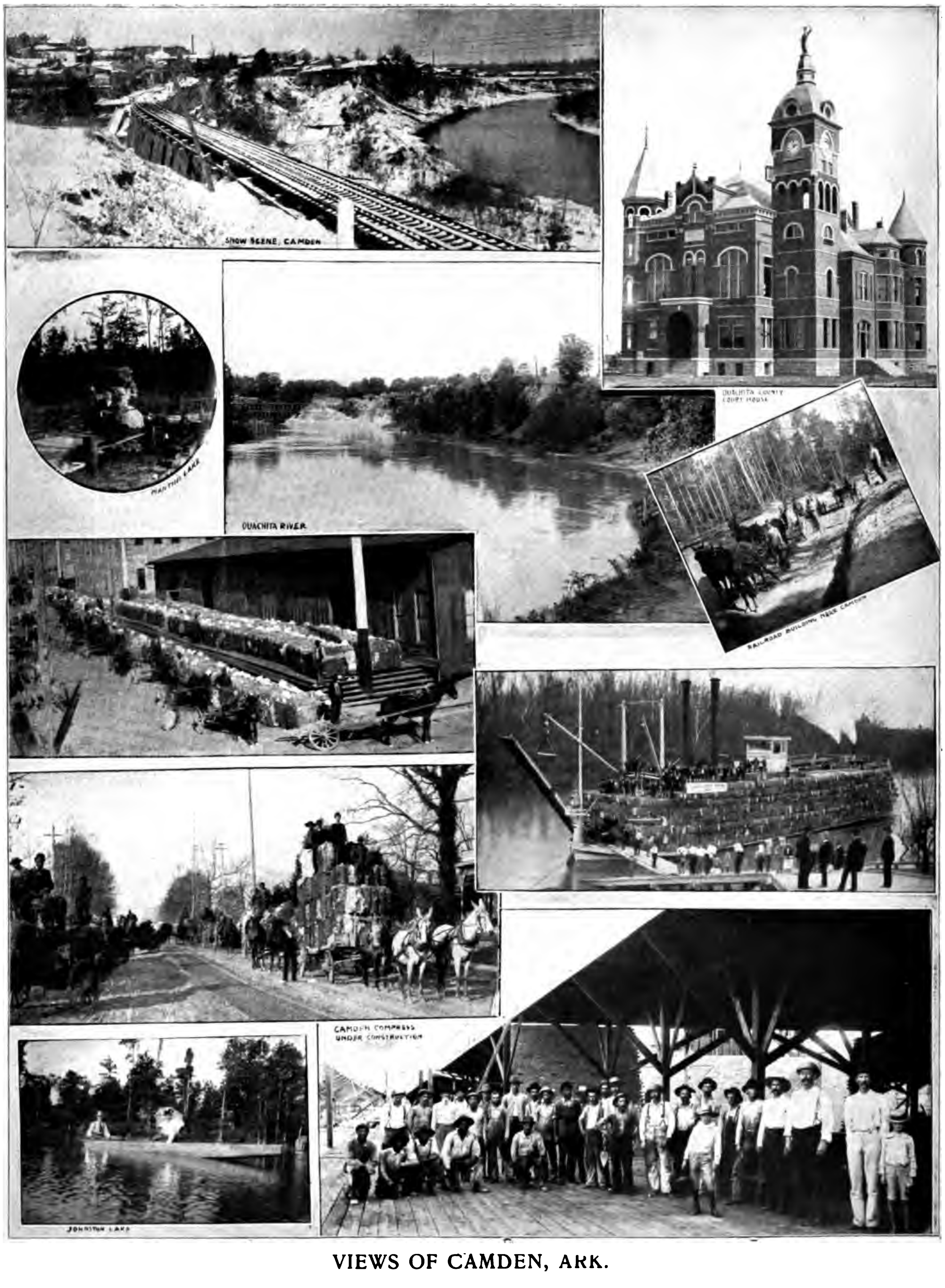
CAMDEN, ARK.

Camden, Arkansas, on the upper Ouachita, is a well built, thriving city of nearly 3,000 inhabitants. It is the center of a large lumbering industry and, besides, is situated in the midst of a very fine agricultural country. It has always been a great cotton market, and is steadily enlarging in this direction. There are two railroads at Camden: the St. Louis, South Western, main line, and the Arkansas Southern R. R., north and south. These, together with the Ouachita River, afford fine shipping facilities to the growing young city.

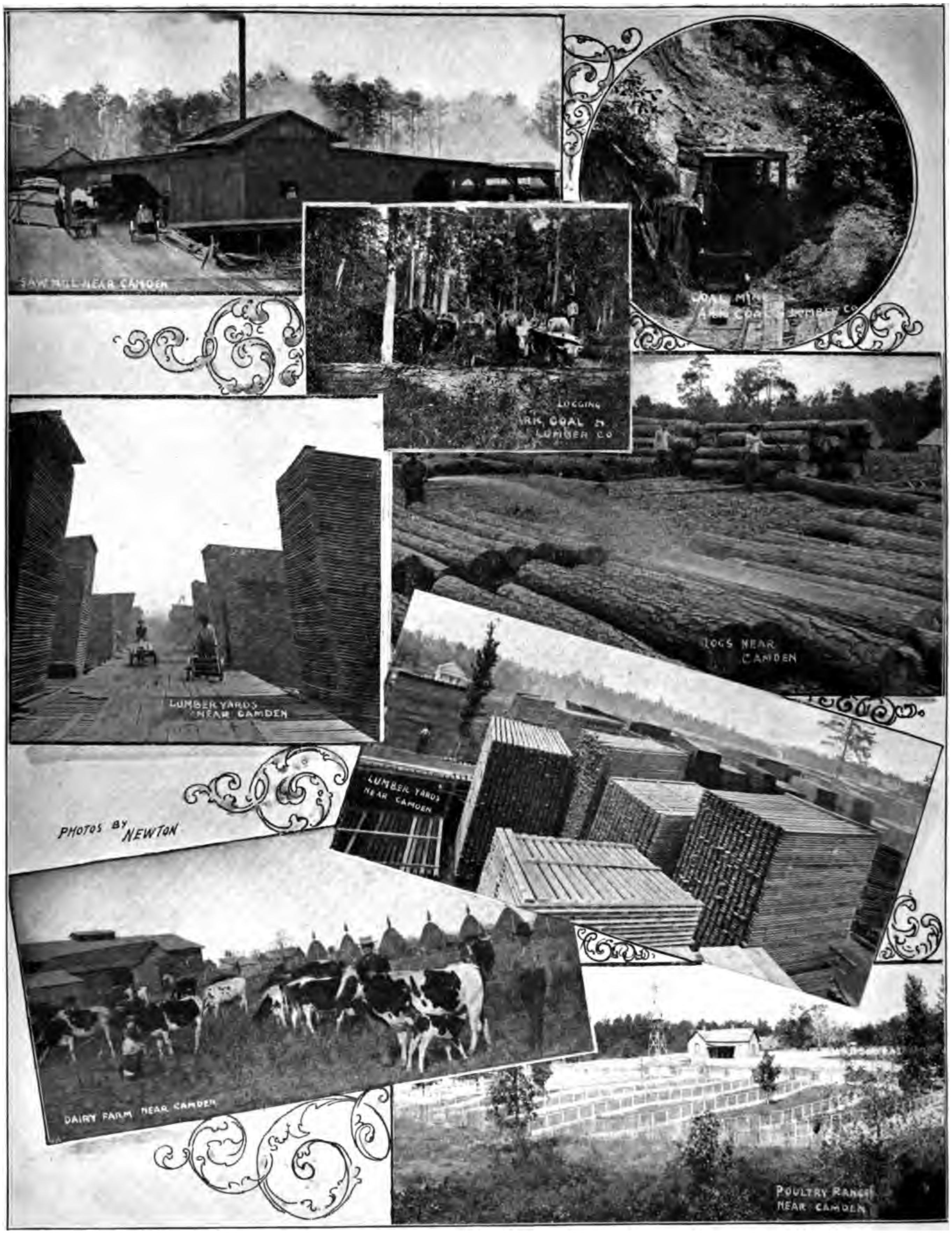
The Ouachita River would be a source of much more economic value to Camden were it made navigable, as is proposed by a system of dams securing slack water navigation when the river is usually low.

At Camden is located what is said to be the third largest cotton shed in the world, which is a part of the equipment of the compress. An engraving of this is shown. Engravings are in the nature of ocular demonstration, and those which represent Camden give some idea of its attractive features.

In industrial enterprises, commercial firms, banks, schools, churches, etc., it is fully abreast with the most enterprising towns of the Southwest. In the beauty of its location, in its healthfulness, in its good morals, and the general tone of its society, it is really an exceptional place.


SNOW SCENE, CAMDEN
OUACHITA COUNTY COURT HOUSE
MARTINS LAKE
OUACHITA RIVER
RAILROAD BUILDING NEAR CAMDEN
CAMDEN COMPRESS UNDER CONSTRUCTION
JOHNSTON LAKE

VIEWS OF CAMDEN, ARK.



VIEWS OF CAMDEN, ARK.

MONROE, LOUISIANA

A. A. FORSYTHE,
Mayor of Monroe

R. A. SHOTWELL,
President Board of Trade, Monroe La.

Monroe is favorable situated on the banks of the Ouachita River, about thirty miles by land, south of the Arkansas State line. It is on the main transcontinental railroad line which connects the East with the West on the 32nd parallel of latitude. This road, the Vicksburg, Shreveport and Pacific Railway, a part of the Queen and Crescent Railway, has recently inaugurated a double daily passenger service, running through trains in connection with the Missouri, Kansas and Texas R. R. at Shreveport and the Southern Railway (Alabama Great Southern Division), at Meridian, Mississippi, thus giving unusual facilities for this section in the way of travel to the East and West. A branch of the St. Louis, Iron Mountain and Southern Railway, which has been built within the last few years, gives it both Northern and Southern connection, and through trains are run to New Orleans twice a day. The same facilities are afforded from Monroe to Little Rock, and St. Louis on the north. Thus Monroe is put in quick touch with all of the commercial sections.

In addition to these means of communication the Ouachita River affords a line of steamboats both North and South. Within the last few years Monroe has grown very rapidly and has made many improvements and additions to its business facilities. It has added very greatly to its appearance by an improvement in the physical condition of its streets and by the building of new residences to accommodate the increased population.

In a statement issued in connection with the Ouachita Valley improvement statistics, it is shown that in the last three years improvements have been made as follows:

New iron (free) bridge across the Ouachita River, costing $70,000; two miles vitrified brick paving, costing $35,000; new brick schoolhouse (just completing), cost $47,000; several miles of gravel paving; a new brick opera house, cost $8,500; wholesale grocery house (Sugar Bros.), $4,400; new Fudikar (brick) hotel, sixty rooms, $7,500; Hudson (brick) office block, $3,750; four brick stores, $7,000; new cotton factory (brick), now under construction, including machinery, $70,000; new Presbyterian Church (brick), $15,000; new Methodist Episcopal Church (brick), $18,000; new Catholic Church, $14,500.

Among the new manufactories are the Monroe Brick Works, the West Monroe Sash and Door Factory, West Monroe Lumber Company, new foundry and machine shops.

In addition to this is the fine cotton mill which is being erected by Monroe capital, an engraving of which is shown, made from the original drawing. This building is being built of brick in a very substantial manner and will be completed and in operation in a few months.

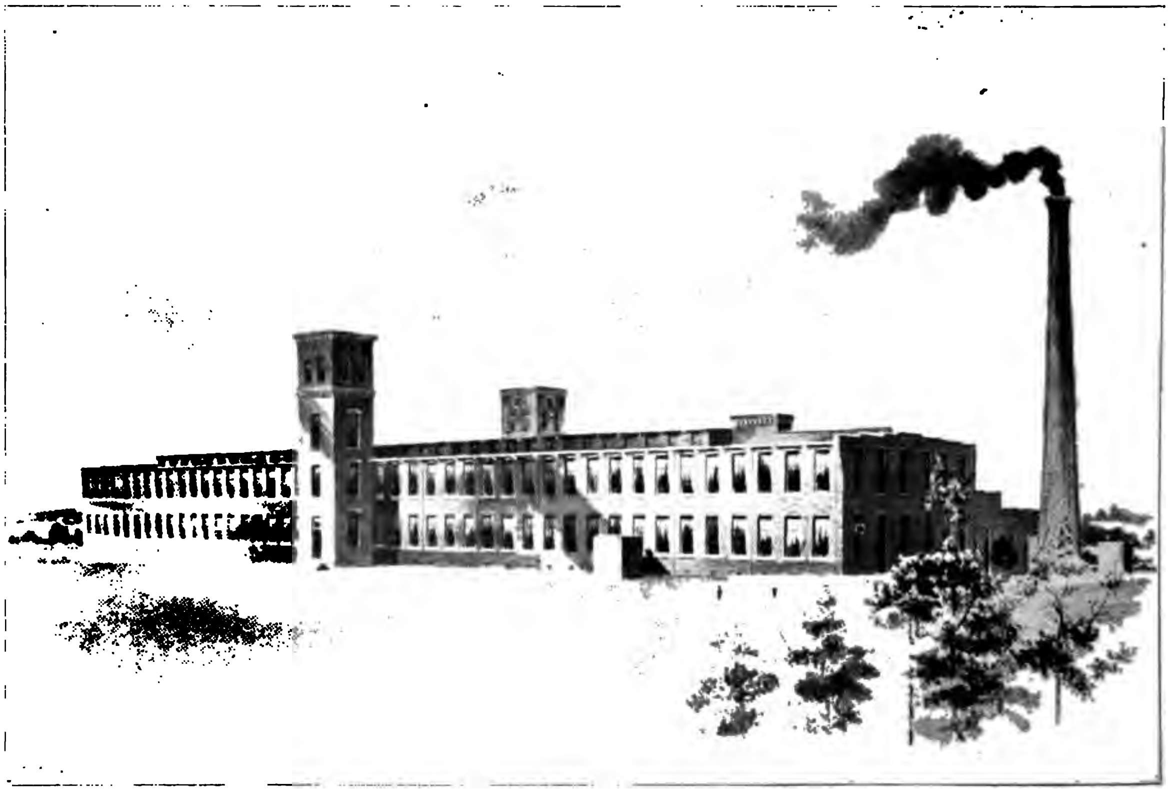
The general industrial condition of Monroe is first-class. They have all the manufacturing facilities in the way of compresses and oil mills that are necessary to handle and prepare for market the large receipts of cotton and cotton seed which are brought to Monroe by rail, wagon and river.

The timber development in the Monroe district is very great and rapidly increasing. With navigation all the year around on the Ouachita River vast quantities of the finest timber, which are now inaccessible, would find its way to Monroe mills. The facilities for the handling of timber are not confined to the cruder manufactures, but they are turning out building material, floors, sashes, doors and other materials. Monroe's location and railway facilities have enabled it to build up a large commercial business which is rapidly increasing.

Monroe has the finest public school building in the State, and several handsome and modern church buildings.

In this description and in the engravings which accompany it, West Monroe is regarded and treated as part of Monroe. It is separate and distinct in municipal government and in other ways, but financially, commercially and industrially the two places are really one.

ST. LOUIS & IRON MOUNTAIN R. R. BRIDGE ACROSS OUACHITA RIVER AT COLUMBIA, LA.



MONROE COTTON MILLS—CONTRACTORS, D. A. TOMPKINS CO.

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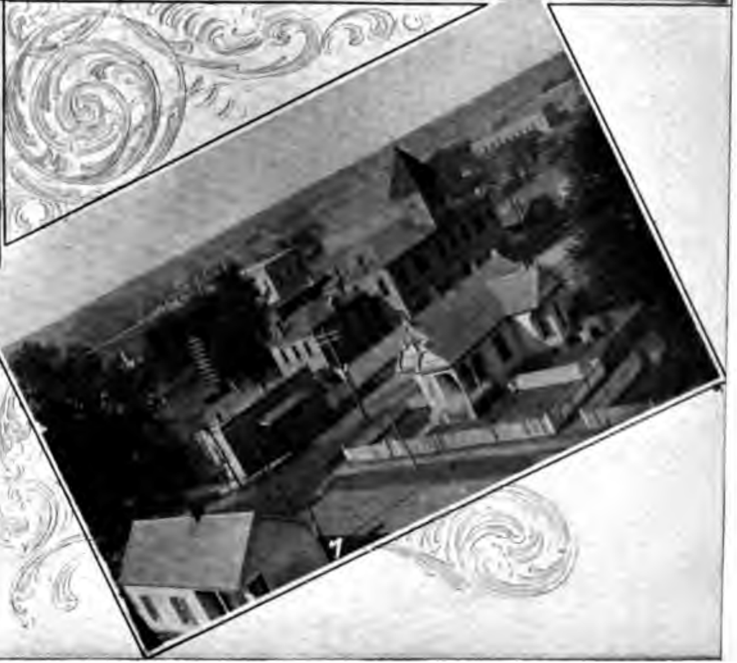
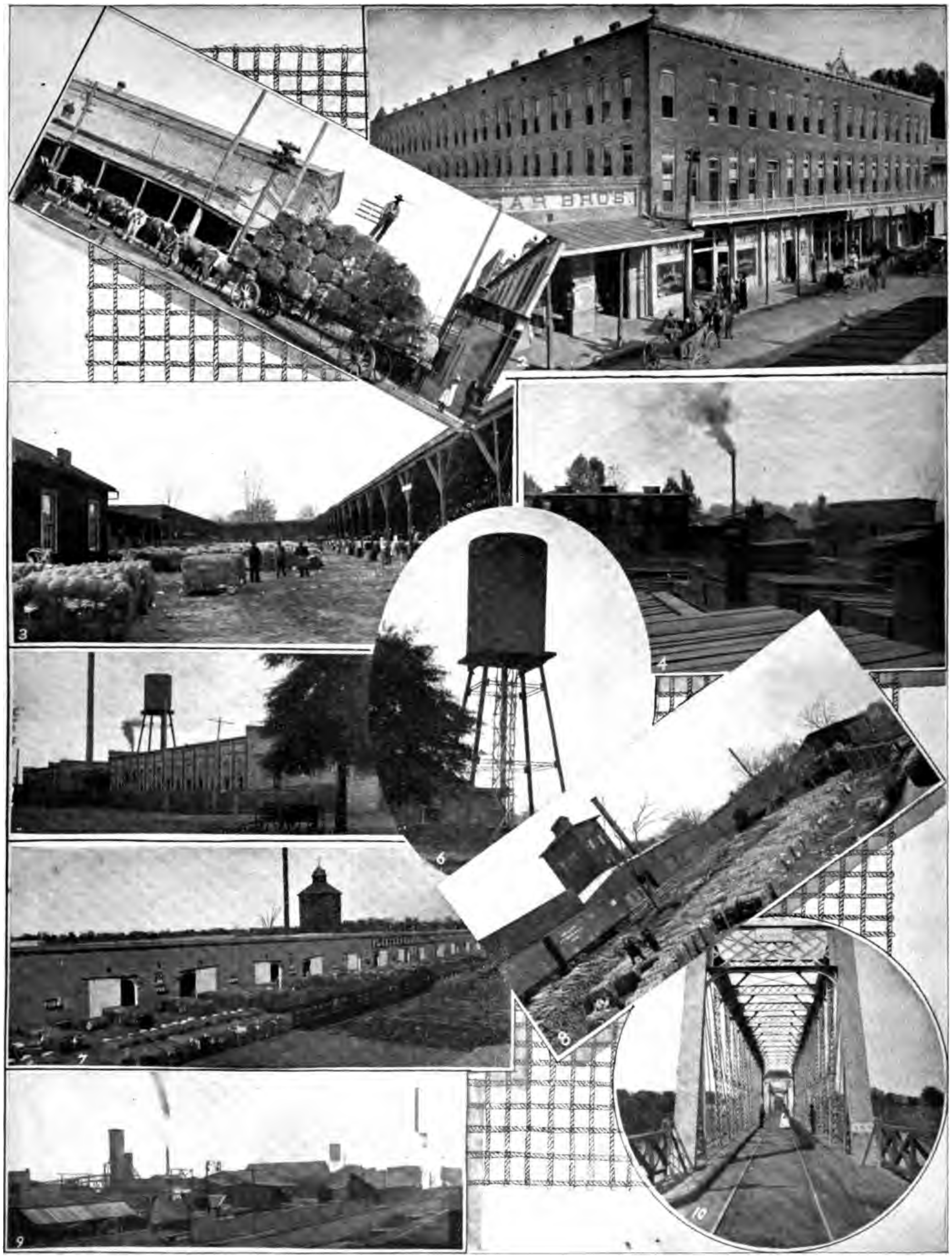


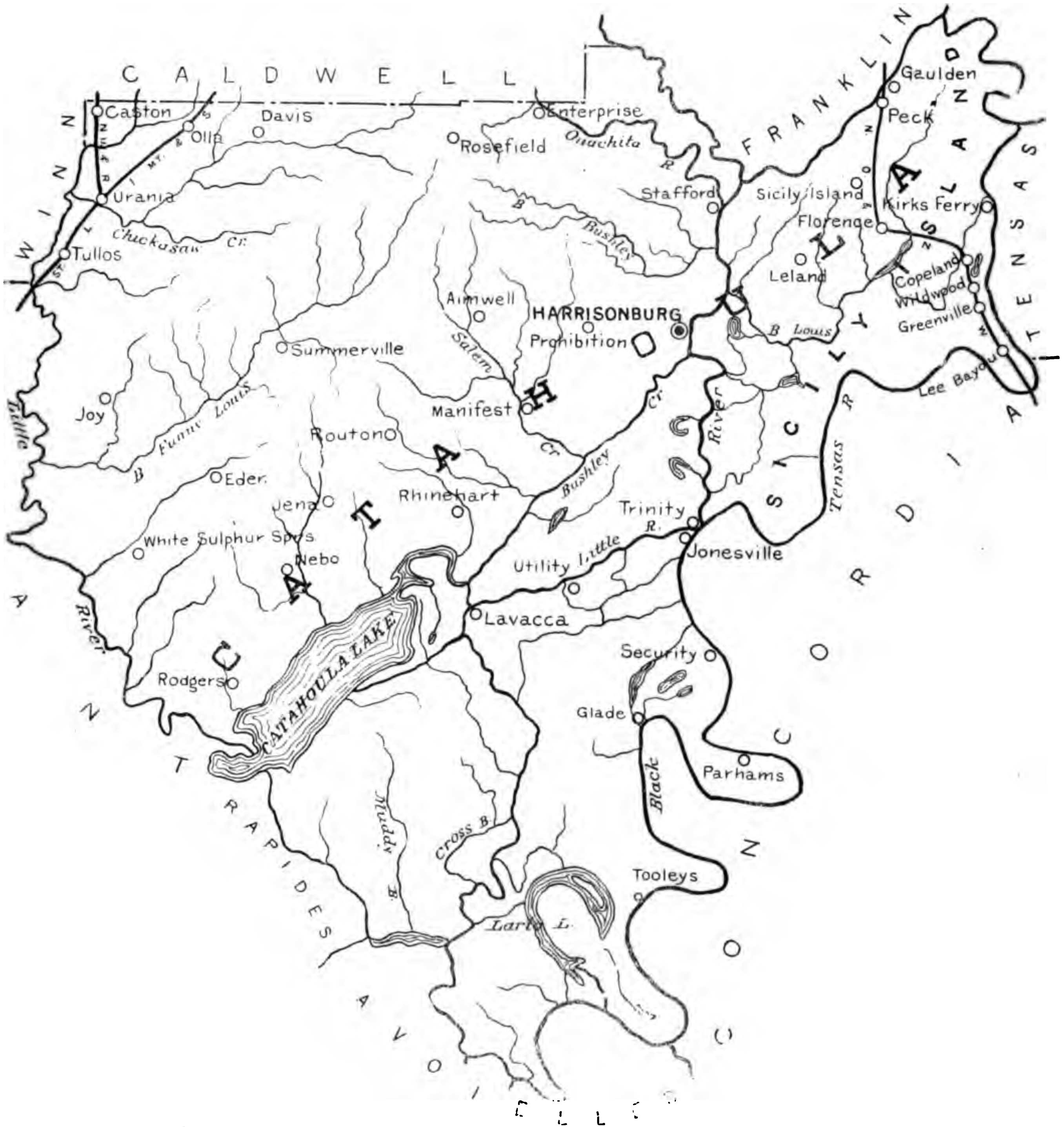
7

1 Wagon Bridge, looking from West Monroe
2 Parish School
3 First Methodist Church
4 Monroe High School
5 Presbyterian Church
6 U. S. Government Building
7 Bird's-Eye View of Monroe from School Tower

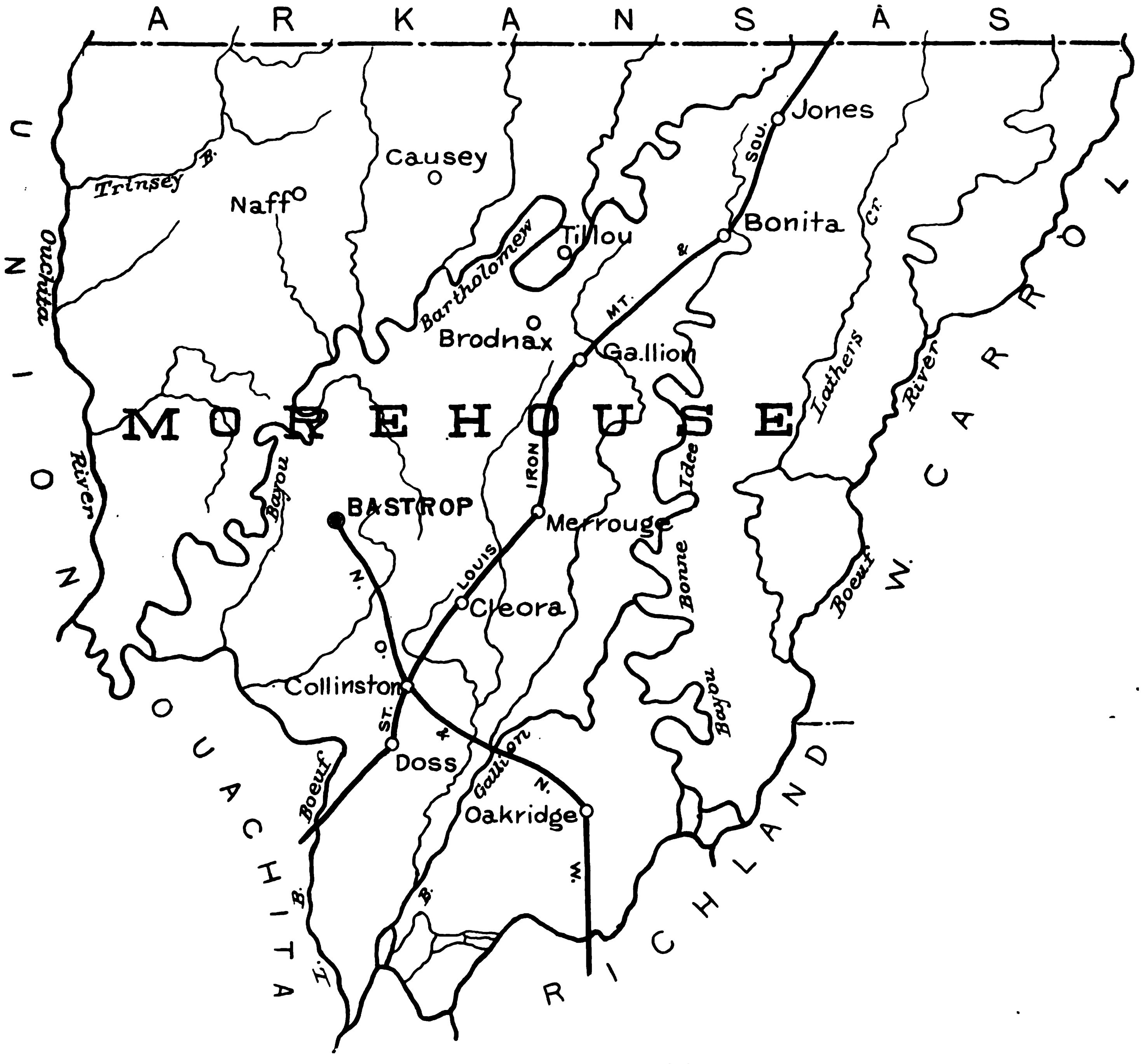
MONROE, LA.



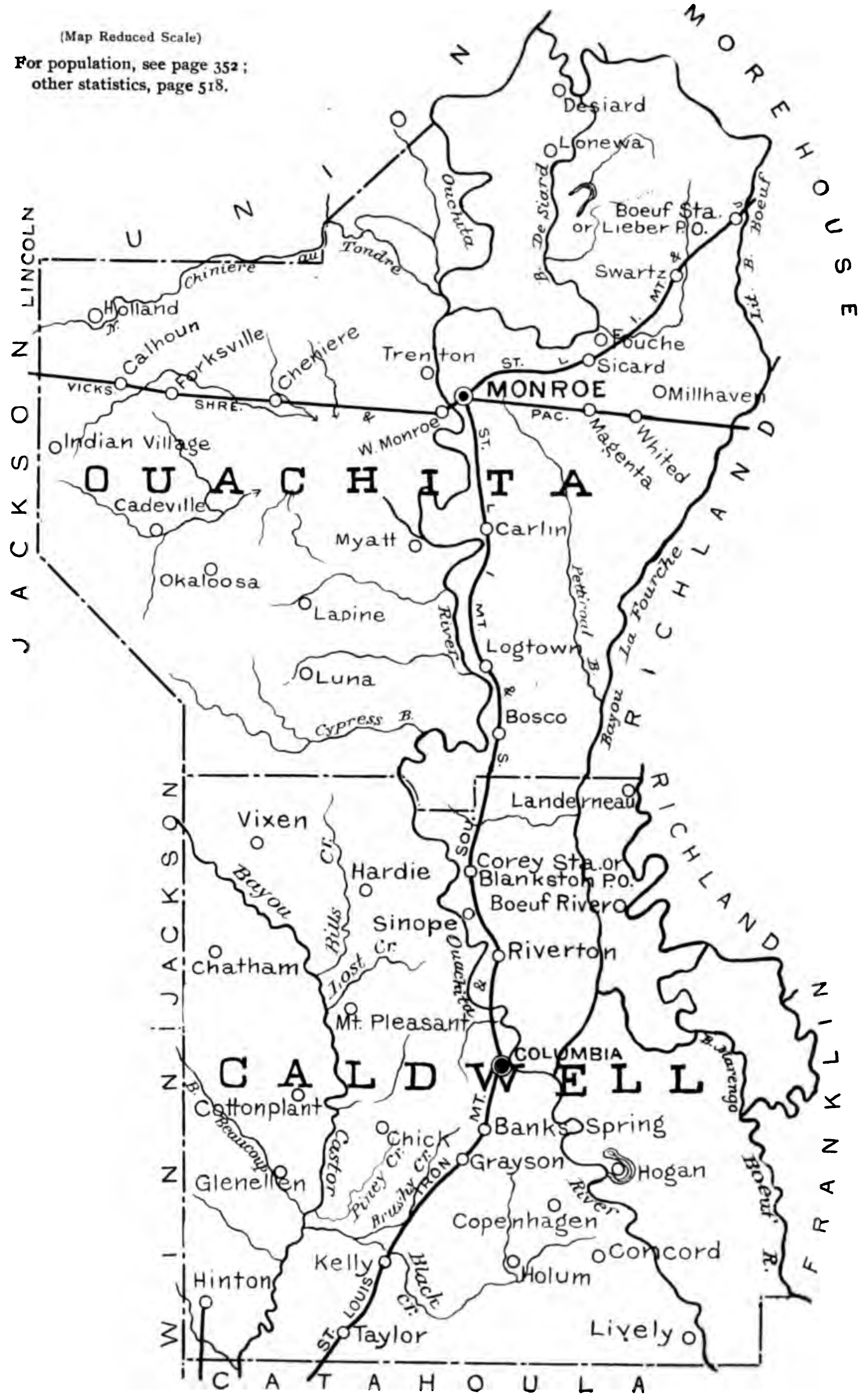
1 A Heavy Haul
2 New Hotel
3 Monroe Cotton Yard
4 West Monroe Sash and Blind Factory
5 West Monroe Oil Mills
6 West Monroe Water Works
7 Planters Compress and Warehouse Company
8 Compress, from the River
9 West Monroe Lumber Company
10 Railroad Bridge across Ouachita River



For population, see page 352;
other statistics, page 518.



For population, see page 352; other statistics, see page 518.



(Map Reduced Scale)

For population, see page 352; other statistics, page 518.

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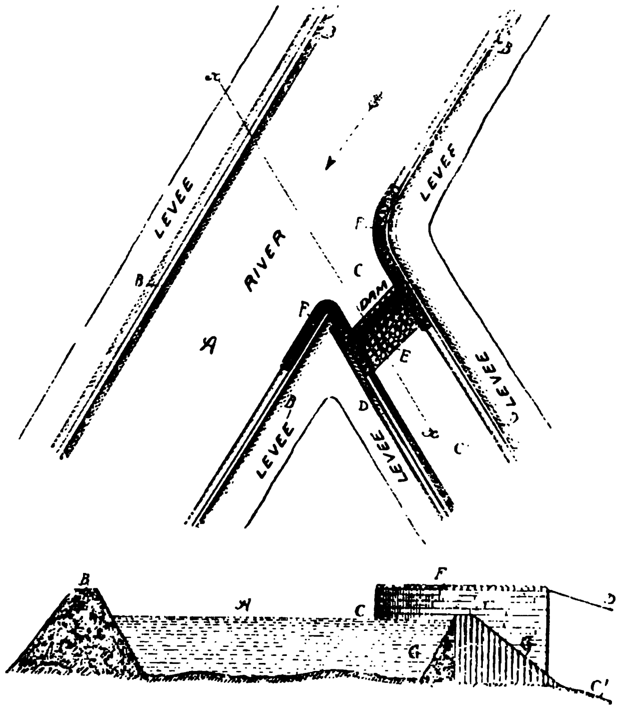
DESCRIPTION OF McCAUGHAN BROS.' PATENT DEVICE FOR THE PROTECTION OF LOW RIPARIAN LANDS FROM OVERFLOW

To all whom it may concern: Be it known that we, William McCaughan and Harper McCaughan, of Gulfport, in the County of Harrison, and State of Mississippi, have invented a new and improved means for protecting riparian lands from overflow, of which the following is a specification:

Our Invention relates to improved means of protecting riparian lands from the overflow of rivers whose banks are protected by levees, as the Mississippi for instance, and it consists in the peculiar construction and arrangement of the several features of the invention, which we will now proceed to describe with reference to the drawing in which figure (1) is a plan view and figure (2) a sectional view taken through the XX; in the drawing A represents the river, whose banks upon each side are protected by raised embankments or levees, BB; in one of the banks we cut an outlet, C, and also provide an outlet channel C back of the opening; said channel C having levees DD upon each side of same; this outlet channel extends to a lower lying basin or reservoir, into which the surplus waters may be received and retained or be drained away to some other outlet. By this construction a portion of the water from the main stream A is led off through the outlet channel, but in order to prevent the water from the main stream from entering the outlet channel at all times we construct a dam E across said channel, near its mouth, which dam is of a predetermined height, being lower than that of the levees and just high enough to permit overflow here when the danger point in the altitude of the main stream is reached from a flood or other cause during the normal flow of the river. This dam forms a part of the levee on this bank of the river. This dam is inclined on each side of its middle to permit a steady rise upon the river side and an easy and gradual flow upon the other side; to prevent violent washing and the destruction of the dams, the levees and dam are constructed in any suitable manner and of any material, and in order to protect the entrance of the outlet channel we construct fenders F at each corner of the junction of the main stream and overflow channel, which fenders extend some distance up and down stream, and also some distance past the dam in the overflow channel. These fenders prevent the washing of the corners; to prevent washing the dam it is provided with a nonerosive face G. As shown, the fenders are made of piles with a heavy plank or timber facing, and the nonerosive face of the dam is also constructed of sheet piles driven perpendicular across the outlet channel. It is obvious, however, that both the fenders and the facing of the dam may be built of masonry, or any suitable material, without departing from our invention.

From the foregoing description it will be seen that in times of flood or freshet the river will rise until it reaches the top of



the dam E, and after this instead of endangering
the river by cutting crevasses in the levees it will
dam, and the superfluous water will thus be dispo
the river cannot rise above a certain level, and its
all times be preserved intact. The overflow pass
may be located at any point along the banks of
as many of them may be provided as is necessary
the extra volume of water.

Having thus described our Invention, what
new, and desire to secure by letters patent is:

1st. The means for preventing the overflow
riparian lands protected by levees, which consists
sive dam forming a part of one of the levees, and
its top at a predetermined distance, below the to
levees, an outlet channel lying back of the said da
for confining the water in said channel substantia
the purpose described.

2d. The means for preventing the overflow
riparian lands protected by levees, which consist
channel way communicating with the main stream
with levees, a nonerosive dam placed across the l
near its mouth, and forming a part of the main
stream at low water, but made of less height th
levees and fenders or guards F, arranged at the j
lateral channel
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this patent-right will make easy terms in the sa
ernment or States of their Invention.

By the use of this system, when the current
increased by high water, a scouring is produced
the channel; whereas, with the levee system th
raises the current, causing still water below, in
a deposit, raising the bottom of the river, thereby
the building of high levees.

WILLIAM McC
HARPER McCA

NOTE—By placing one of these outlets so as to surround
lands with the levees to said outlets, and with a second overf
said lands and levees, to continue and conduct the surplus w
outlet, a still-water pond or lake is formed to receive and de
ing high water, thereby producing a filling to reclaim said la
banks of the river in low places to form the most fertile field